Packing House and Cold Storage Construction

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and
Cold Storage Construction

A GENERAL REFERENCE WORK ON THE PLANNING, CONSTRUCTION AND EQUIPMENT OF MODERN AMERICAN MEAT PACKING PLANTS WITH SPECIAL REFERENCE TO THE REQUIREMENTS OF THE UNITED STATES GOVERNMENT AND A COMPLETE TREATISE ON THE DESIGN OF COLD STORAGE PLANTS, INCLUDING REFRIGERATION INSULATION AND COST DATA.
FULLY ILLUSTRATED.

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PREFACE

It has been the aim of the author in preparing this work, to present a complete treatise upon the subject, of practical value to those directly interested in the construction and maintenance of packing plants and cold storage buildings.

That there is a demand for such a work, has been evidenced to the author by numerous inquiries from architects and owners, and also by the fact that there exists no similar work describing modern American methods and materials.

The requirements of The Bureau of Animal Industry in Washington regarding the sanitary construction of packing plants, have been carefully considered by the author in presenting the illustrations and text pertaining thereto.

The chapters on cold storage construction contain information which heretofore has only been available through a close study and investigation of existing buildings or through scattered descriptions and discussions of this subject in current technical journals.

In describing methods of construction, the author has drawn largely from his own observation and experience of what has been successfully tried and tested in actual practice, although much assistance has been obtained from prominent authorities in the various subjects mentioned in the work. A great deal of valuable information has also been derived from various books and publications to which reference has been made in the text. To all such the author gratefully acknowledges his indebtedness.

In a book of this character, illustrations are worth many pages of writing and the drawings have been prepared by the author with that object in view. Lengthy explanations have been avoided for the reason that the work will only interest those who already are more or less familiar with the subject, either from a technical or operating standpoint.

To make the book convenient for practical use and ready reference, the various subjects have been paragraphed in bold face type and carefully cross-indexed.

H. PETER HENSCHIEN.

Chicago, Ill., September 1, 1915.

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CHAPTER I

PACKING PLANTS

Introduction

The great progress made in the packing industry during the past few years is particularly noticeable with regards to buildings and equipment. The improvements along these lines are most apparent and far in excess of the natural progress of evolution, which is always found in any form of industry.

When the Federal Meat Inspection Law was passed in 1906, the packers were brought face to face with the fact that there was room for much improvement in their establishments, and that the government intended that these improvements should be made. The law gave the United States Department of Agriculture legal power to supervise the sanitary conditions of all plants doing an interstate business.

The Bureau of Animal Industry now requires that all packing plants, in which there is government inspection, be placed in a sanitary condition, satisfactory to the Bureau. It also requires that complete plans for new buildings be sent to Washington for their examination and approval, in advance of construction.

The recommendation which the Bureau has made regarding construction, sanitation and certain particulars of equipment must be carried out in all new work, and this has largely been the incentive that has led to the well constructed and sanitary packing house buildings of today, where a high standard of cleanliness is maintained and where the working facilities are favorable both for man and product.

Before this law was enacted, packing houses were built with scant regard to sanitary conditions. The nature of the business compelled many owners to locate their plants outside of city limits and frequently in the least desirable neighborhoods, if within the city limits. This attitude of the public largely influenced the owners to limit the outlay of capital invested in buildings and equipment. The plants were often poorly planned and constructed, and the materials used were not of the kind best adapted to meet the requirements in a packing house.

The result generally was that these plants were costly to operate and maintain and are now gradually being replaced by new buildings of more modern construction.

To produce the best result in packing house planning, without unduly increasing the cost, requires an intimate knowledge of the conditions under which these plants are operated. The technical problems to be considered and the selection of the materials and equipment best suited for the purpose, are of such importance that only those thoroughly trained by experience and investigation can produce satisfactory results.

General Features and Requirements

Most of our present packing plants are the result of gradual growth and enlargement. Starting with small buildings, others have been added from time to time, often without regard to the best ultimate result in economy of operation. There are many of these establishments on which enough money has been spent in additions and repairs, to more than cover the cost of an entirely new plant. The profits of such plants are substantially reduced by high operating cost, upkeep and insurance.

The modern packing house establishment of average size is made up of a number of buildings grouped together in a manner best suited to handle the business of each particular plant, and there can be no set rules for the location of one building with relation to its neighbor. The requirements of each establishment must be considered individually.

Before deciding on the general features of a new plant a careful study should be made of the conditions and requirements confronting the new enterprise so that all immediate needs are taken care of, and future growth is provided for through practical and economical development of all departments. Careful study must be given to the arrangement of each individual building with relation to all other buildings and departments therein, so that products and materials are handled to the best advantage throughout the plant.

It is, therefore, important that the designer be given a thorough working knowledge of the owner's business before he attempts the planning of the entire plant. The importance of a practical arrangement from an operating standpoint is evident, when we consider that the labor cost in a packing plant is seventy-five per cent of the money expended in converting the raw material into a finished product; the other twenty-five per cent is for administration expense, interest, depreciation and insurance.

The selection of the site on which the establishment will be built, determines to a large extent, the arrangement of the various buildings with relation to each other.

Where the property is located within city limits and bordered by streets, alleys, rivers, or by railroad tracks, the designer is often compelled to produce an arrangement which is far from ideal, and this accounts for many of the makeshift plants found in nearly every city.

It is with the view of locating the plant on a suitable piece of land that the suggestions as to the most practical and economical arrangement of buildings are set forth.

Location

Location is one of the first things to be considered when establishing a packing plant.

In most of our larger cities there has been established a stock yards district where live stock is brought for sale and distribution, and it is within such districts or in their immediate vicinity, that the owner of a proposed new plant frequently must look for his location. Where plants are

established in or near a small city, a better selection of land is generally assured.

It is of importance that the property selected should be that best suited for packing house purposes, and that the most necessary requirements from a building and operating standpoint are available.

The modern packing house, more than any other manufacturing plant, requires ample room, good ventilation and sunlight, and should be located only where the surroundings can be kept in a sanitary condition, and where the ground is dry and well drained. The site must have railroad connection and a good wagon road leading to the premises. There must be adequate sewer connection to carry away all surface water and sewage.

An abundant supply of pure water must be available at all times, and particular attention should be paid to the source from which the water is obtained in order that it may be used without detriment in the preparation of meat food products. Chemical analysis should be made of the water to ascertain if it is suited as boiler feed water.

The water problem has been of such great importance to the packing house industry in the past that we find many of the present establishments situated on or near the river banks of our cities, where water can be obtained at low cost, and the sewage carried away by the river.

When considering the advantages of river location it should be remembered that such lands are frequently badly drained, and are subject to overflow when the rivers are flooded.

During the flooded period business must be curtailed or suspended entirely, until the water subsides far enough to allow the cellars and sewers to be drained.

The cost of constructing buildings on low grades, near a body of water, is increased by the additional foundations and waterproofing required to properly support and protect the buildings.

These facts should be considered by the owner in advance, and competent advice obtained regarding the

technical and sanitary difficulties to be anticipated on the location selected.

Shipping Facilities

Transporting the raw and manufactured products to and from the premises is one of the most important problems to be considered in the arrangement of any large manufacturing plant. This is particularly so in a packing plant where the handling of perishable products makes it necessary that shipments are made with the least delay. When goods are ready to load in cars, there should be sufficient facilities to handle the entire shipment with dispatch as well as economy in labor.

It is therefore advisable to provide railroad tracks at all shipping points of the plant, and the buildings should be arranged so that the shipping of one class of goods will not interfere with that of another. Where coal and live stock are brought to the plant in cars, separate tracks should be placed alongside the boiler room and stock pens, so that the cars may remain undisturbed until unloaded.

Plants doing a large local business must have ample room for shipments by wagon, and the loading facilities arranged so that teams can drive up in front of the shipping room where local goods are made up ready for delivery.

These requirements are of first importance in practically all establishments, and the simplest way of arranging the plant is, therefore, to place the buildings alongside two or more railroad sidings with shipping platforms running the full length of the buildings. The wagon platform should be on the side most convenient to the roadway.

Principal Requirements in Packing House Planning

Of equal importance to the shipping problem is the grouping of buildings, so as to secure the greatest economy in the labor cost of transferring the products from one department to another. In this connection it is necessary to consider the requirements of the Bureau of Animal Industry, that no edible products shall be conveyed through or stored in rooms which contain any of the inedible products.

From an operating standpoint the killing floor in a packing plant will be considered as the starting point. Practical experience has located the killing department on the top floor of the slaughter house. In modern plants this will be on the fourth floor, as live stock can easily be driven to this height without detriment to their condition.

With such an arrangement we have the live stock conveyed by its own effort to a point from which the dressed carcasses and all the byproducts can be transferred by gravity, or by a minimum of labor, to their proper place of storage or manufacture.

The fresh meat is taken to the chilling rooms which are frequently located on the same level as the killing floor, but in an adjoining building. The offal and other byproducts are dropped by gravity to other floor-levels, and there separated and cleaned and made ready for further distribution to other departments or places of storage.

Directly below the killing floor is the offal department, and all products going from here to the rendering tanks, are trucked over to the filling floor in the tank house, without the necessity of using elevators for raising or lowering the offal, as is often the case in less modern plants.

The building in which the rendering tanks are placed is known as the tank house, and is generally located as a separate building, convenient to the slaughter house. This is done, principally, to provide sufficient light and ventilation on as many sides of the two buildings as possible.

The fertilizer building is often placed adjacent to the tank house, although it should be kept as far away from all edible food departments as can be conveniently arranged for, and the window openings should be left out on all walls which face directly upon any other building in which edible products are stored. The oleo department and bone cooking, in beef killing plants, should be placed close to the slaughter house. In smaller plants, these departments are placed on the lower floors of this building. Otherwise they are located in the bone and oil house adjoining the slaughter house.

The coolers for hanging dressed carcasses, or for storage of meats should be in buildings which are used for cold storage purposes only. Even the smallest plants should provide for this and not locate the chill rooms below the killing floor, as is often done in poorly arranged plants.

The cooler buildings can be conveniently located across the railroad tracks from the slaughter house, and the dressed cattle and hogs conveyed over a bridge to the hanging rooms which are built on the same level as the killing floor; when the coolers are placed below the level of the killing floor, an inclined conveyor or elevator is used to take the carcasses down.

The meat curing rooms, freezers and shipping coolers are placed on the lower floors, as required.

The manufacturing building, where finished products such as lard, sausage and smoked meats are handled, should be convenient to the cooler building, tank house, and smoke houses, so that all products used in the manufacturing can be transferred economically from one building to another.

The boiler and engine room should be in separate buildings and located adjacent to the buildings where steam and refrigeration is most needed. Live and exhaust steam for cooking and heating purposes is required on practically every floor in the tank house, lard refinery and bone and oil house.

Natural Light

In order to give adequate light and ventilation to all buildings and departments, it will be necessary, in many instances, to separate the buildings, and make use of the space between them for light and ventilating courts.

This space can be utilized, on the first floor, as driveways, or trucking passages between buildings, and for railroad tracks.

One of the principal requirements of the Bureau of Animal Industry is that natural light and fresh air be admitted to all rooms where food products are prepared or stored. This does not include coolers, curing cellars or oleo seeding rooms. It would be advisable, however, to

arrange for outside ventilation in these rooms by a limited amount of window openings, so that the rooms could be aired and ventilated, if desired.

The best arrangement of buildings in which the manufacturing and slaughtering is done, would be to shape the buildings so that daylight could penetrate the entire depth of all rooms. This would limit the width of the building to 80 feet and require a maximum amount of window openings in both side-walls.

Windows should not be placed over four feet from the floor line and should extend up to within a few inches of the ceiling in order to throw the light into the room as far as possible.

The value of sunlight as a disinfectant is so important in a packing house that careful attention should be given to the number and arrangement of windows. When the requirements necessitate the use of wire-glass windows for fire protection, it is advisable to use the clear wire-glass instead of the ordinary rough glass, as the latter obscures the light and keeps the direct sunlight from entering.

Skylights should be placed in the roofs of buildings where much sunlight is desirable on the top floor. This refers particularly to the slaughter house and all manufacturing buildings. The skylights should run North and South in order to give the best results and be provided with sufficient ventilation to take off all foul air.

Ventilation

A thorough ventilation of all rooms in a packing house is necessary in order to maintain sanitary working conditions for the employees and prevent putrefaction.

By proper distribution of windows and doors in a well designed plant it will be possible to secure satisfactory natural ventilation in most departments, during the time of the year when the windows can be kept open. But when the outer air becomes cold, as in winter, the windows are closed more or less, and the rooms are poorly ventilated.

This condition will prove most objectionable in those departments where hot water and animal heat create an

atmosphere filled with vapors, often to such an extent that one cannot see half way across the room. Mechanical ventilation must be provided and heating pipes installed to overcome this objectionable condition during the cold months when windows and ventilators cannot be kept open.

The best result in ventilation is obtained by rotary fans and a system of air ducts, which will exhaust the foul air from the room and supply pure air at the opposite side from the place where the air is removed.

The current of incoming air should not be of a higher velocity than three feet a second, unless the ducts are placed so high above the floor that the air will not strike directly on the workmen.

When mechanical ventilation is employed, the intake for fresh air should be placed so as not to be near the fertilizer building or catch basins.

The most economical fan to operate would be a rotary fan of large size, operated at low pressure, and driven either by a separate motor or from a line-shaft operating other machinery.

Natural ventilation can be obtained with good results in the lower stories by an intelligent arrangement of flues, built into the brick walls. The inlet to such flues should be close to the ceiling and the opening made of the same area as that of the flue.

The author believes that if such flues were installed in sufficient numbers in tank houses, sausage rooms and similar manufacturing places, they would do a great deal to overcome the badly ventilated condition which so often exists in even the most modern plants.

Communication Between Buildings

Communication between departments located in different buildings must be so arranged that it will not be necessary to convey any of the nonedible products of the carcasses through rooms used for edible products. For this reason, separate communication should be provided between the offal floor and the tank house for the trucking of edible and inedible products.

The same ruling applies to elevators and it is, therefore, required that where elevators are used for the handling of hides, fertilizer and other inedible products, they are to be used for such purposes only, and separate elevators must be installed to handle the edible products.

Where buildings adjoin one another and are separated by a fire wall, the communication should be through a fireproof vestibule. This will prevent a fire in one building from spreading to the next building and tends to reduce the insurance rate.

Underground communication between cellars should be provided for, so that goods can be transferred without the use of elevators. Tunnels can be constructed under the railroad tracks to serve as passageways and for running pipes and conduits from one building to another. This method of installing the numerous water, steam and refrigerating pipes will be found very convenient, and far superior to the usual method of running the pipes in covered trenches, or on overhead supports.

The expense of constructing the tunnel will be covered by the reduced cost of installing the piping and the ease with which repairs can be made afterwards.

Column Spacing

The most practical and economical spacing of columns in any manufacturing or storage building is one which permits the utilization of space between the columns with the least loss of room. For this reason, a spacing of 16 feet from center to center of columns has been universally adopted in packing house construction.

In a cooler building, divided into 16 foot sections, the hanging rooms for hogs will have six rails per section and the distance between the rails is sufficient to allow the air to circulate freely between each row of hogs.

In a beef cooler there are in each section, six rails, four of which are hanging rails, the other two being used for transferring quartered beef to other parts of the cooler. This spacing allows room for the buyer to pass between each row of beef carcasses when making his selection.

In curing rooms we find that the 16-foot sections will accommodate three rows of curing vats of standard size (1,500 lbs.) and leave room between the single and the double row of vats for a working alley. When this is repeated in the next section, all vats will stand in triple rows with a working alley between.

On the killing floor, two beef beds are placed in each 16-foot section.

In the tank house, four 6-foot rendering tanks are supported in one section.

From a construction standpoint the same spacing of columns is equally satisfactory where timbers are used for the support of floors and roof. Mill constructed buildings can be designed economically with timbers of such size as are easily obtainable in most lumber yards and mills.

With reinforced concrete construction, the floor slab can be supported on girders of moderate size without the use of intermediate floor beams. This is of particular advantage when refrigerating pipes are placed overhead.

Planning for Future Expansion

When a plant is designed for its present requirements only, and no provisions are made for future expansion, the owner may find later on, that it will be impossible to enlarge his output without making costly changes in the part of the plant already built.

It is always possible to increase the killing capacity of a new plant without enlarging the killing floor, whereas the coolers and other departments may be inadequate to take care of the increase in killing. This condition applies to all plants and the designer should arrange the buildings so that there is room for growth, or addition, on at least one side of each building.

Where the ground area is limited, or the value of the land is high, the capacity of the plant may be enlarged to better advantage by adding more stories to the buildings. In such case the foundations and lower stories must be built of sufficient strength to support the additional weights that may be placed upon them.

When it has been determined how the enlargement of the plant can best be taken care of in the future, all building walls, which later on may become party walls between two buildings, should be constructed so as to carry the additional loads from the future building. The recommendations of the fire underwriters regarding party walls must also be considered.

In buildings of small area, such as tank houses and boiler and engine rooms, it is often advisable to erect a temporary wall on the side on which the future addition may be built, and remove this wall later on, in order to avoid a division of the building. These temporary walls should always be built with columns and beams to support the floors and roof and the columns and beams must be made strong enough to carry both the old and new construction. Where the roof is carried on trusses over boiler and engine rooms, which rest on the permanent side walls, these will support the loads from the roof and also in this case the temporary end wall need only be strong enough to support its own weight.

CHAPTER II

PLANS AND DESCRIPTION OF A MODERN PACKING PLANT

Capacity and Construction

The illustrations, Figures 1 to 8, inclusive, show the arrangement of an establishment doing a general packing house business, under Government inspection.

Cattle, sheep and hogs are slaughtered and the byproducts handled and cured to a finished commercial product. The plant is designed for a daily killing capacity of 200 cattle, 400 sheep and 1,500 hogs.

All buildings are of fireproof construction with brick walls and reinforced concrete floors and roof. Firewalls have been built wherever it was necessary to separate one part of the plant from another and the principal requirements of the fire insurance companies have been complied with.

By referring to the first-floor plan, Figure 1, the general arrangement of the plant can best be studied. The buildings have been grouped with the intention of leaving room for future expansion on at least one side of each building, and, at the same time, give light and ventilation to all departments where manufacturing or slaughtering is done.

Railroad tracks have been placed convenient to all shipping points in the plant, and separate railroad sidings are provided for coal and live stock. The team loading is handled in a wagon court placed in front of the cooler building, adjacent to the street.

The fertilizer building and live stock pens are placed

as far away from the street as the arrangement would permit, and they are served by a separate railroad siding at the rear of the property.

The general offices and the men's dressing room and toilet station are in separate buildings which are not shown on the ground plan.

Slaughter House

This occupies a central location with light and ventilation on three sides. The north end adjoins the boiler and engine room, and as these buildings are only one story high, the slaughter house will also get light from this side above the second story.

All killing is done on the fourth floor and the live stock is driven up from the stock yards over an inclined runway placed on the east side of the building. Storage and resting pens have been provided at three different levels in order that an ample supply of live stock may be kept at hand during the killing hours.

The slaughter house floor is divided by a brick partition into two rooms, one for the slaughtering of cattle and the other for hogs. Four beef killing beds, with a capacity of 200 cattle per day, have been provided, and also space for small-stock killing, where 400 sheep and calves can be handled daily.

The hog killing arrangement provides for a capacity of 1,500 hogs per day. The equipment includes a double hog wheel, two sticking rails, hog scalding tub with conveyor, one large scraper and moving hog bench. After the hogs have been gambrelled and hung on the dressing rails, they are kept moving on the rail by a variable speed conveyor until dressed and ready for the chill-rooms. Ample space is provided for the Government inspection of retained hogs. This retaining room is well lighted and is fitted up with rails for the storage and final inspection of all retained carcasses.

All offal and byproducts from the killing floor are passed by gravity chutes to the floor below and there separated and cleaned for further distribution and manufac-

ture in other departments. Tongues, hearts, brains, etc., are trimmed and sent to the coolers. Heads and feet are cleaned and trimmed before being taken to the tank house or bone cooking vats. Tripe is washed and cooked or sent to the curing coolers and all casings are cleaned and packed away in salt until shipped.

On the third floor is also located a part of the oleo oil department, which is separated by a partition from the rest of the occupancy on this floor. The oleo equipment includes fat cutter, two chilling vats, hasher and two melting kettles.

The second floor is occupied entirely by the oleo department, excepting a small room for the drying of bones. The oleo oil is drawn from the kettles to the clarifiers and then placed in seeding trucks for storage. Two oleo oil presses are provided, as well as a press table and stearine bin.

The first floor is partly insulated and used for the storage of oleo oil, which is kept in the cooler at a temperature of 50° Fahr. until shipped. The oil is collected from the presses into an elevated receiving tank and then drawn into tierces and placed in the cooler.

The remaining room on this floor is used for storing tallow and stearine.

The cellar under the killing building is used for curing of hides and sheep pelts. Salt storage is provided under the platform adjoining the railroad tracks where the salt can be conveniently unloaded from the car.

Cooler Building

The dressed carcasses of cattle, sheep and hogs are conveyed from the slaughter house over a covered bridge to the cooler building, which is located across the railroad tracks, with frontage on the street. This building is divided by a brick fire-wall into two sections, one for pork products and the other for cattle and sheep.

Each section is five stories high with a cellar. There are three elevators and stairways placed in fireproof vestibules and all communications between the buildings are through openings protected by double fire-doors.

Pork Building

The top floor of this building is used as a pipe loft for the hog hanging coolers on the fourth floor. These coolers are on the same level as the killing floor and have a hanging capacity of 3,000 hogs, figuring one hog for every 14 inches of rail space. The coolers are divided by insulated partitions into 16 foot sections, with six hanging rails in each section. One cooler is reserved for leaf lard.

The three lower stories and cellar of the pork building are used for the curing of pork products and are refrigerated by direct expansion piping, placed on the ceiling.

Beef Building

This building is arranged as follows: On the fourth floor (Fig. 5) there are two beef coolers, with pipe-lofts above, and a cutting room for hogs. The warm beef chill-rooms have hanging rails for 240 cattle, figuring one side of beef for every 16 inches of rail space. The storage cooler has a capacity of 800 sheep and 400 cattle, allowing 14 inches for each side of beef. The cutting room for hogs has a high ceiling and is well lighted by windows and skylights.

The third floor is divided into five rooms as shown in Figure 4. The meat-sorting and trimming room is placed directly under the cutting room on the floor above. The adjoining room is used as an offal cooler in which livers, tripe, brains, etc., are hung or spread on racks until shipped out or sent to the adjoining sharp freezer room. The sausage-meat cooler is used for the storage of trimmings and other products which are to be made into sausage. The sausage meat is prepared in the room adjoining the cooler. This room is kept at a temperature of 45° to 50° Fahr. and contains the sausage machinery.

The second floor (Fig. 3) is used for freezer storage and pipe lofts for the beef coolers below.

On the first floor (Fig. 1), is located the wholesale market and the shipping cooler. The hanging capacity is 400 cattle, with additional storage space for miscellaneous beef

cuts, pork loins, etc. Adjoining the market cooler are two smaller rooms for hanging and packing sausage and boiled hams. One room is used for smoked goods and is kept at a temperature of 45° to 50° Fahr. The other room is for boiled hams, liver-sausage, etc., which should be kept at a temperature of 32° to 34° Fahr.

The two South sections of the first floor are not insulated and are used as shipping room and office, in connection with the market. All orders for goods which are to be shipped out by wagons are made up in this room, ready for delivery.

The entire cellar (Fig. 2) is insulated and used for the curing of beef and pork products. Salt storage is provided under the shipping platform which is adjacent to the railroad tracks.

Manufacturing Building

Adjoining the coolers to the East, is the manufacturing building, which is three stories high, with a cellar under the entire building. The sausage factory is located on the top floor so as to be convenient to the sausage coolers in the adjoining building, where the meat is prepared ready for stuffing. This is done in the manufacturing building, where two compressed air stuffers have been provided.

The link sausage is hung on cages which are suspended from overhead rails, placed along each stuffing table and continued to the smoke houses and cook rooms, located on the same floor. The sausage is taken down on the elevator and hung in the coolers on the first floor and there packed.

That part of the top floor which is not required for the sausage factory, is used for the lard refinery. Prime steam lard from the tank house is stored in the large receivers which are placed along the north wall. The lard is pumped from here to the refining kettles and mixed with Fuller's earth, and after passing through the filter presses, it gravitates to the refined lard receivers. From these receivers it is pumped back to the agitator tank and then cooled over the lard-rolls on the floor below.

The kettle-rendered lard is hashed and melted on the top floor. The equipment includes one Enterprise hasher, two melting kettles and two neutral oil kettles, with strainers and receiving tanks on the floor below.

The second floor is used entirely by the lard refinery. The finished lard is here cooled, drawn off into tubs and tins and sent to the cooler for storage until shipped.

On the first floor is located the hanging and packing room for smoked hams and bacon. The partition around this room is made with open slats and screened in order to give free ventilation through the room. The smoked meat is hung on trolleys and air-dried before being wrapped and boxed. This floor is also used as a storage and shipping room for all manufactured goods which are to be shipped by railroad or wagon.

The cellar is used for the soaking and washing of sweet-pickled meats. Hams and bacon are soaked in concrete vats and are washed and hung on trolleys before being taken to the smoke houses. The remaining cellar-room is set aside for the storage and washing of empty tierces, cooperage, etc.

Smoke House

Adjoining the manufacturing building are the smoke houses for ham and bacon. All communications between the two buildings are through a vestibule with door-openings protected by double fire-doors.

The firing pits and wood storage are in the cellar and the smoke houses above are three stories high. Each house has a total smoking capacity of 5,400 lbs. The sausage smokers are located on the third floor with firing pits on the floor below.

Tank House

To the south of the slaughter house and separated from this by an open court is the tank house, which is a three-story and basement building, divided into two sections. The division wall starts at the first floor level and is continued up to the roof, and the cellar is left undi-

vided. This arrangement is required by the Bureau of Animal Industry, in order to separate the tanks in which the edible products are rendered from the tanks containing inedible products. The rendering tanks are filled on the third floor, which is on the same level as the offal floor in the slaughter house, and all offal and fat is trucked across on steel bridges, connecting the two buildings.

The second floor of the tank house is omitted, except for a narrow gallery around the tanks for drawing off lard and grease. This arrangement provides good light and ventilation to the cooking room and the steam and odors are readily carried off through the windows and ventilating flues. Below the rendering tanks are placed the skimming boxes, one box for each two tanks, into which the residue is dumped after the lard is drawn off. The inedible department contains also a large blood-receiver with cooking tank on the first floor.

The cellar is used for the pressing and drying of fertilizer. Two hydraulic presses are installed and the pressed tankage is dried in the fertilizer building.

This is a one-story building with cellar. On the first floor is installed a complete plant for the evaporation of the tank water, which is stored in concrete vats, placed outside of the building and equipped with steam coils for heating the water.

The pressed tankage which contains about fifty per cent moisture is elevated from the cellar to the first floor by an inclined conveyor and is then thrown into a screw conveyor and mixed with the stick from the evaporator. This mixture is dumped into the tankage drier in the cellar where the moisture is extracted. The dried tankage is then spread over the cellar floor to cool and afterwards screened and stored on the first floor, ready for shipment. The product is sold to manufacturers of hog food.

The pressed blood is dried in the small rotary drier in the cellar and stored on the floor above. The fertilizer equipment also includes a disintegrator for grinding tankage as well as bones and tailings from the screens.

Catch Basin

This is located to the east of the slaughter house and extends down below the cellar floor, so that all floor drains will be discharged into the basin. The skimmings are collected in a steel tank and blown, under steam pressure, up to the grease rendering tanks.

Boiler and Engine Rooms

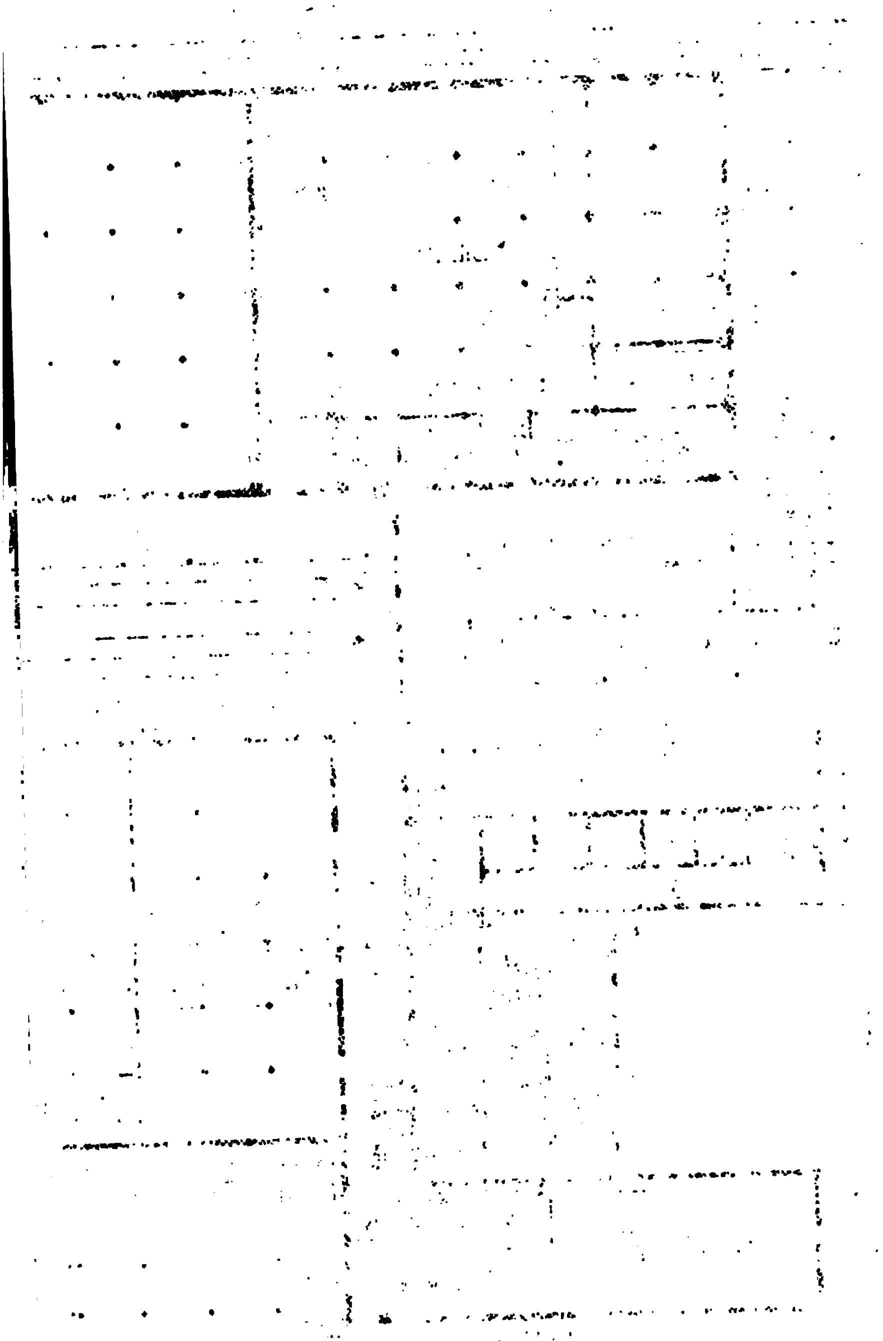
These are located adjoining the slaughter house and are constructed so that the north wall can be removed for future extension. The boilers are located at the level of the cellar floor and the coal is dumped direct from the cars into a storage bin below the track. Coal elevators and hoppers are installed for gravity feed to the chain grates in front of the boilers.

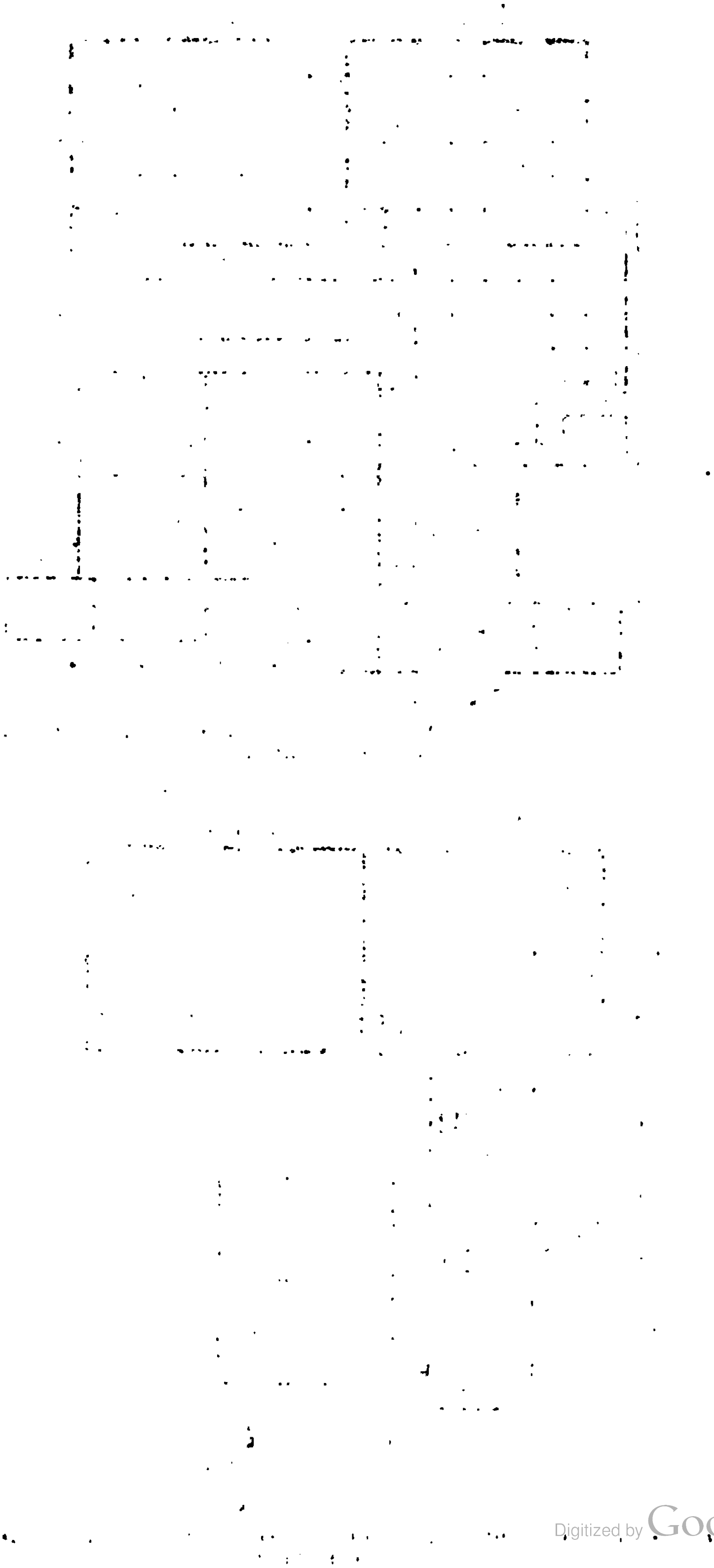
The cellar below the engine room is excavated and the machinery foundations are built up from the cellar floor. The space between the foundations is used for pumps and for the exhaust pipes from the refrigerating machines and generators. The floor of the engine room is built around the machinery on a level with the outside grade.

The ammonia condensers are placed on the roof and are enclosed with louvres on three sides in order to permit the free circulation of air through the condenser house.

A water reservoir is built adjoining the engine room, where the overflow water from the condensers is stored for fire purposes, or pumped from here to the plant and used for the washing up of floors.

The stock yard is built with covered pens and is paved with brick. An inclined runway, over which the live stock is driven to the killing floor, is built on the east side of the slaughter house.





CHAPTER III

PLANS AND DESCRIPTION OF A BEEF AND SHEEP KILLING PLANT

Capacity and Construction

In Figures 9 to 15, inclusive, are shown the plans for a beef-killing plant with a capacity of 600 cattle and 500 sheep per day.

The plant is designed for shipments of beef in carload lots and is equipped for handling all by-products. A compound lard refinery and a small canning factory have also been arranged for.

The construction is fireproof, with brick walls and concrete floors. The recommendations of the National Board of Fire-Underwriters have been complied with as far as was considered advisable, without unduly increasing the cost or handicaping the economical operation of the plant.

The buildings have been arranged so that additions can be made to all of the buildings without demolishing any of the present work.

The general arrangement of the plant is best illustrated by the first story floor plan, Figure 9.

It will be seen that three railroad tracks have been provided in the space between the cooler and killing building. These tracks are used for the icing of refrigerator cars and shipments of beef. An ice plant is installed for the manufacture of ice, and ice-crusher, hopper and other necessary equipment for car icing installed. The car icing is done with iron buckets, running on a rail, placed over the center of the cars, see Figure 15. The men doing the icing, walk on the top of the cars, pushing the buckets in front of them. The empty buckets run on the return track back to the

crusher for refilling. Salt is handled in the same manner.

The space, where the refrigerator cars are loaded and iced, is covered for protection against the weather. The roof is placed at a height which will permit the switching crew to stand on top of the cars. This is required by the State laws as well as by the railroads, and the minimum clearance between the top of the rail and all overhead obstructions must be 22′ 6″.

On the west side of the slaughter house is located the boiler and engine rooms, tank house, and fertilizer building. These buildings are served by a separate railroad track which is also used for the loading of hides from the cellar under the slaughter house.

Plans and sections show the occupancy of all floors in each building, so that only a brief description of the plant will be set forth.

Fourth Floor

The killing of both cattle and sheep is done on this floor (Fig. 13). The arrangement provides for eight cattle beds with a capacity of 600 cattle per day, and the sheep killing ring is of sufficient size to handle 500 sheep per day.

Storage pens for live stock have been placed outside of the building on the same level as the killing floor, so that a supply of both cattle and sheep is always on hand ready for killing.

Third Floor

The dressed carcasses are taken to the coolers on the third floor (Fig. 12) by an inclined conveyor on the bridge over the railroad tracks. The chill-rooms are on this floor and have a hanging capacity of 500 cattle and 1500 sheep.

The offal cooler and adjoining freezer storage are used for storing livers, tongues, hearts, brains, etc., either fresh or frozen. All offal from the killing floor is dropped to the third floor, where it is separated and cleaned. The edible offal goes to the cooler, the fat to the oleo room or to the tank house and the bones are handled and cooked in an adjoining room.

All buildings are connected by bridges at the third

floor level so that products can be trucked or conveyed by overhead trolleys from one department to another. A canning factory is shown in the oleo building. The equipment includes everything necessary to make canned goods on a small scale. The third floor also includes the laundry for the plant and the office and toilet room for the Government inspectors.

Second Floor

The space in the cooler building is used for pipe lofts and freezer storage. In the slaughter house there is storage room for casings and dried bones (Fig. 11).

The entire floor in the oleo building is set aside for oleo seeding and pressing. Adjoining this, in a separate building, are the dressing and toilet rooms for the employees. All cooking in the tank houses is done on this floor and the tallow and grease drawn off to the receivers.

First Floor

The storage and shipping coolers for beef (Fig. 9) have a hanging capacity of 600 cattle. These are brought down from the chill room on the third floor by an inclined conveyor and by the beef-drop adjoining the elevator.

The sales cooler for local trade has a hanging capacity of 250 cattle and storage space for beef-cuts and other products.

The shipping-room is conveniently located near the car-loading platform and the wagon court and has a small office space for the shipping clerks.

The main office is placed at the front of the plant, in a separate building which is two stories high with cellar. The balance of the room on the first floor in all buildings is principally used for storage and shipping of goods which are manufactured on the floors above.

Cellar

The cellar space in the cooler building (Fig. 10) is used for the storing of barrel beef, tripe or other tierced goods. There is a tunnel under the railroad tracks which connects the salt storage rooms underneath the loading

platforms. Hides and sheep pelts are stored in the cellars of the slaughter house and the oleo building. The fertilizer is pressed and dried in the tank house cellar and elevated to the first floor of the fertilizer building.

The boiler and engine rooms are excavated to the same depth as the rest of the plant. Coal storage is provided in front of the boilers and the coal is emptied directly into the bins from the cars on the railroad tracks above.

The foundations for the refrigerating machines and generators were built up from the cellar floor-level and the space between the foundations was used for the running of exhaust pipes. A wood floor was placed around the tops of the foundation at the first story floor-level.

The stock yard was built at the south end of the property between the railroad tracks on each side of the plant. The pens are laid out so that live stock can be unloaded from the cars on two sides of the yard.

Compound Lard Manufacturing Plant

The equipment of the packing plant previously described includes the tanks and machinery necessary for the refining of cotton seed oil and the manufacturing of compound lard.

Most of this equipment is placed in the edible department of the tank house, where the oil is refined and the lard is manufactured. The finished product is pumped over to the first floor of the slaughter house and there cooled and packed.

Compound lard is cotton seed oil compounded with oleo, stearine or tallow, and sometimes both.

The crude cotton seed oil is delivered in tank cars and weighed on the track scale in front of the tank house. The oil is pumped from the car to the crude oil refining kettles on the third floor, where it is mixed with caustic soda, heated and stirred by a revolving agitator. The clear oil is siphoned off and afterwards pumped through a filter-press to remove any foreign substance. The oil is then known as "Yellow Oil," which is a refined bleachable cot-

ton seed oil. This is stored in the large storage tanks in the yard south of the tank house. The sediment and impurities left in the crude oil kettles is known as "Foots" and is drawn off into the tanks directly below the refining kettles, where it is boiled and further treated with caustic soda before it is packed and sold as soap stock.

The scale tank shown over the crude oil refining kettles is used for weighing the lye before it is mixed with the oil.

Before the oil is manufactured into lard, it must be treated to remove all odors. This is done in the deodorizing tanks with live steam at a pressure of 135 pounds. From here it is taken to the small refining kettles and compounded with stearine and about 3 per cent of Fuller's Earth. This is pumped through a filter-press and from there gravitates back to the receiving tanks. The finished product is now ready to be cooled over the lard roll and from there filled into packages.

CHAPTER IV

PLANS AND DESCRIPTION OF HOG PACKING PLANT

Capacity and Construction

In Figures 16 to 23, inclusive, are illustrations of a hog killing plant with a daily capacity of 1200 to 1500 hogs. The arrangement includes the buildings and equipment necessary to cure and store the output, manufacture lard and sausage, smoked meats, and for the conversion of all inedible products into the finished commercial fertilizer.

The plant is of reinforced concrete construction and arranged for future expansion in all departments. The buildings are planned to conform to the recommendations of the insurance underwriters and are divided by firewalls into sections, so as to separate the fire-hazard of one occupancy from that of another.

The manufacturing and killing are done in buildings separate from those where the products are cured and stored, in order to obtain the lowest basic rates on each individual section of the plant, based upon the principal occupancy. All communications between sections are through standard vestibules with double fire-doors. All openings in exposed walls are protected by fire-doors or metal windows with wire glass. The power plant is in separate buildings and a large water reservoir is provided for fire purposes.

The buildings are located on both sides of the railroad sidings and are connected on the upper floors by bridges. On the north side of the tracks (see first story floor plan, Fig. 16) are placed the slaughter house, tank house, fer-

tilizer building, and the boiler and engine rooms. On the other side are the hog coolers, pork warehouses, manufacturing building and smoke houses.

The illustrations are sufficiently detailed to show the occupancy of each building and, therefore, only a short description of the plant will be given.

Slaughter House

This is four stories high, with cellar. The killing is done on the top floor, which has a very high ceiling. The room has ventilation and light on four sides as well as in the roof.

The hog pens are at the north end and are built with three decks for the storage of hogs as they are brought over from the yards.

The equipment on the killing floor consists of a double hog wheel and two sticking rails; concrete scalding tub, scraper, moving bench, and hog dressing conveyor; all arranged as shown in Figure 20.

Ample room, with inspection and storage rails, has been provided for the government inspectors.

The chain conveyor delivers the hogs into the open air hanging room which will be described later.

The third floor is used for offal cleaning, handling of casings, etc. It is connected with the tank house and with the cold storage and manufacturing buildings by bridges, as shown in Figure 19.

The second floor is used as storage room for casings. The balance of the floor space is set aside for the use of the employees; with dining room, dressing room and toilet room in separate compartments.

The stair on the outside of the building leads to the shipping platform at the first floor level and it also connects with the third floor bridge, so as to give ready access to the toilet room from all parts of the plant.

The first floor is used for storage of grease in tierces and as a general shipping room. The west section is fitted up with offices and toilet rooms for the plant superintendent, time-keeper and Government inspectors.

The cellar is used as storage for box chucks, cooperage, etc., and is connected with the rest of the plant by a tunnel under the railroad tracks, so that boxes and tierces can be taken to any elevator in the plant.

Tank House

This is three stories high, with cellar, and is separated from the slaughter house by a ventilating court, 16 feet wide.

The tanks are filled on the third floor and the products are trucked over from the offal department and from the trimming room.

Lard and grease are drawn off from galleries above the first floor so that the second floor may be omitted, in order to thoroughly light and ventilate the cooking room. The latter is divided by a brick partition into edible and inedible compartments as required by the Government.

The tankage and blood are pressed in the cellar and taken to the driers in the fertilizer building.

The east wall of the tank house is supported on concrete columns and beams, so that the temporary brick panels can be removed whenever the building needs enlarging.

Fertilizer Building

This is a one-story building with cellar and has a pent house on the roof, over the fertilizer screens.

The fertilizer is dried in the basement by two rotary driers and spread over the floor to cool. It is then elevated to the screens and stored on the first floor. The tailings go back to the bone mill for grinding and again pass over the screens.

An evaporating plant for tank water is installed on the first floor and the water is stored in concrete vats at the east end of the building, before it is pumped to the evaporating pans.

The walls of the fertilizer building support the columns for the three decks of hog pens above as shown in Figure 22.

The stock yards are located along the railroad tracks

and the hogs are driven to the elevated pens, over an inclined runway on the west side of the plant.

Catch Basin

This is placed between the evaporator room and the inedible department of the tank house. It is 60 feet long with double compartments, four feet wide, and with a skimming platform in the center. This size basin will handle 300,000 gallons of water per 24 hours.

The skimmings are piped to the blow tank and raised by steam pressure to the rendering tank.

Boiler and Engine Room

The power and refrigerating plants are located in separate buildings, which are excavated to the cellar floor level. Coal is dumped from cars placed on a separate track in front of the boilers, which are fired in the basement.

The machinery foundations are built up from the cellar floor level and the space between the engine beds is used for running the exhaust steam piping. A 6-foot tunnel under the railroad tracks has been provided for all service pipes and electric conduits required in the south section of the plant.

The ammonia condensers are located on the roof over the engine room and are enclosed by louvres on all four sides. The overflow water from the condenser pan is stored in a large reservoir and used for cleaning up around the plant.

Open Air Hanging Floor

The space over the railroad tracks between the killing floor and the cooler is used for air-drying of hogs before they are taken into the coolers. The hanging capacity of this floor is 1200 hogs or one day's killing output.

The room is constructed with continuous window openings in each end wall and has a high ceiling and ventilator in the roof, as shown in Figure 22. The draft created by the open windows and ventilators will quickly circulate all the vapors arising from the hogs, and force the warm air up along the inclined ceiling, where it passes out through the ventilators.

The floor is well drained to the sewers and insulated so that water will not freeze on it during cold weather.

Hog Coolers and Warehouse

The hogs are chilled on the fourth floor of the pork warehouse and this is divided by a fire-wall into two separate sections and used for cold storage purposes only.

The coolers have a hanging capacity of 2900 hogs and the floor-space is divided into four large coolers and each of these is subdivided by a cross-partition into two sections. This arrangement is made necessary by the use of the spray system of refrigeration, which requires more width in the coolers than is usually required when pipe-coils are installed.

The fifth story floor plan (Fig. 21) shows the arrangement of the brine loft and the location of the warm and cold air-ducts.

The hog cutting room is located adjoining the coolers and the trimmings for sausage-meats and lard refining are dropped to the trimming room on the floor below.

On the third floor is located the offal freezer and sausage cooler and a large curing room for dry salt meats.

The second floor is used for freezer storage and for dry salt meat curing.

The first floor is used in part for storage of lard, sweet pickle meat curing vats and as a shipping room. The cellar is used entirely for sweet pickle meat curing.

Salt storage is provided under the loading platform where salt can be dumped directly from cars into storage.

Manufacturing Building

This is four stories high with cellar. The top floor is one large, open room, well ventilated, and fitted up with rails for hanging smoked meats and sausage before they are packed and boxed for shipment.

The third floor is used for sausage manufacturing and lard refining. The location is convenient to the sausage cooler, smoke house and trimming rooms in the adjoining building. The prime steam lard is pumped over from the tank house.

The manufacturing floor is lighted and ventilated on three sides and the sausage cook room is open to the roof, through the story above.

The sausage equipment includes two hashers, two cutters, one mixer, and two stuffing tables. Overhead tracks are placed alongside the stuffing tables and the sausage is hung on trolleys and run into the smoke houses. The tracks extend from here to the cook room, where the sausage is cooked in steel vats. The cooler is fitted up with rails and racks for hanging sausage before it is packed.

The lard refinery is equipped with refining kettles, filter presses, receivers, agitators and lard rolls for making prime steam lard. Part of the equipment is shown on the second story floor plan (Fig. 18).

Neutral and kettle-rendered lard are hashed and melted on the third floor and the finished lard is strained and packed on the second floor.

The first floor is used in part for the main office of the plant and as a general shipping and storage room for boxed goods. Orders are here made up for delivery, either by wagon or rail, and covered loading platforms are built on both sides of the shipping room.

The cellar is used for soaking and washing sweet pickled meats before they are taken to the smoke houses.

Smoke Houses

These are three stories high with firing pits in the cellar. The building is shut off from the manufacturing building and all communication is through standard vestibules with double fire-doors.

The sausage smokers are on the third floor with firing pits on the floor below.

All smoke houses are equipped with overhead rails and the meat is hung on trolleys in the cellar and taken up on the elevator and run into the smoke houses.

The capacity of each house is 12 trolleys with 450 pounds of meat each, or 5400 pounds per floor. This will give a total smoking capacity above one fire of about 16,000 pounds, and altogether 96,000 pounds in the six houses.

CHAPTER V

PLANS AND DESCRIPTION OF A CHICAGO PACKING PLANT

In Figures 24 to 27, inclusive, is illustrated a small, compactly built plant, erected in Chicago, Ill., on a limited ground area, bounded by streets and alleys.

The plant is operated under Government inspection and has a capacity of 300 cattle, 400 sheep and 300 hogs per day. While the coolers are designed for this capacity, the killing floor is large enough for handling a considerable increase in the output. This is sold principally to the retail trade in Chicago, and is delivered by wagon from the front of the plant. Provision was also made for shipment of beef in carload lots, and railroad tracks were provided for at the rear of the property to handle car shipments. Another track was placed on the south end of the plant for the receipt of live stock.

The available space at the time the plant was built was limited to the area shown on the ground floor plans, Figure 25. The space was divided by brick walls into separate occupancies and arranged so that the principal requirements of the insurance companies could be complied with.

The slaughter house is centrally located, with the cooler building on one side and the tank house, power plant and other departments on the opposite side.

The killing is done on the fourth floor and the room is well lighted and ventilated by windows on three sides and by skylights. Six killing beds for cattle were provided, giving a daily capacity of 400 cattle. The space

reserved for sheep killing is ample for the handling of 400 sheep.

The hog killing space is enclosed by a solid partition, in order to confine the steam from the scalding tub and scraper. The daily output of 300 hogs requires about four hours' time for slaughtering, on account of the short dress-

H. P. Henschien, Architect.

FIG. 24—PACKING PLANT OF PFAELZER & SONS, CHICAGO, ILL.

ing rail and the limited floor space. The space over the killing floor is used in part for the storage of empty trolleys and gambrels, and also as dressing and toilet rooms for the employees working on that floor.

The offal is handled on the third floor, in the space adjoining the tank house. The remaining part of the floor is occupied by the fat chilling vats, hasher and oleo melting

kettles. The second floor is used for oleo clarifying and draw-off, lard refining, bone cooking and storage.

On the first floor is the hanging and packing room for smoked meats, oleo and lard storage, cooper shop and shipping room. Hides and tallow are stored in the cellar.

The cooler building is five stories high, with a cellar, and is arranged so that the loading court for wagons, on the street side, is made a part of the building. The third floor and the stories above are built out to the sidewalk line and extend over the loading court below.

The longitudinal section of the building, Figure 27, shows the occupancy of all the floors. The top story is the refrigerating loft for the coolers on the third and fourth floors. The hanging capacity of the fourth story cooler is 875 hogs, 300 cattle and 400 sheep.

On the third floor is an offal cooler and hanging room for 750 cattle. The rear of this room connects with the car-shipping platform and all shipments by rail are made from the third floor level on account of the elevation of the railroad track.

The first story cooler has a hanging capacity of 500 cattle and is refrigerated by a low pipe loft in the mezzanine deck between the first and third floors. This arrangement brings the third floor of the cooler building to the same level as the third floor of the slaughter house. The cooler is used also as a wholesale market and is fitted up with cutting tables and racks.

The cellar in this case is used for the curing of pork products and has a storage capacity of 800,000 pounds of meat.

The offices of the plant are over the loading court and the corresponding space on the fourth floor is used for freezer storage and hog cutting, while the sausage factory is on the fifth floor.

The tank house is built of fireproof construction, with separate compartments for edible and inedible products. The equipment includes the necessary tanks and machin-

ery to handle the products, including fertilizer press and drier.

The smoke houses are three stories high with firing pits in the cellar. The capacity of each house is 5400 pounds of meat on each floor, which gives a total smoking capacity of 33,000 pounds.

The live stock pens are built five stories high with inclined runways extending from floor to floor. The large openings in the outside walls are made continuous through all stories and covered with louvres.

The power plant is located so that the coal can be dumped from the railroad cars directly in front of the boilers.

The plant is of mill construction, with the exception of the tank house, which is built of reinforced concrete. The insurance requirements were complied with in all details of the construction and fireproof vestibules built where the arrangement and space would permit. The rate of insurance on the plant is as follows:

Cooler Building	$0.65
Slaughter House	1.43
Stock Pens	0.90
Tank House	0.66
Power Plant	1.43
Smoke Houses	1.93

The rate on the contents, $0.96.

The cost of the building, including all equipment, was $205,000.00.

CHAPTER VI

KILLING FLOORS

Cattle and Sheep Killing Floor

In Figures 28 and 29 is illustrated a killing floor, which is designed according to the most modern practice of handling cattle and sheep. The arrangement provides for eight cattle beds, with a capacity of 600 cattle per day, and the sheep-killing ring is designed for 150 sheep per hour.

The size of the building and all principal dimensions are given in the illustrations. It will be noticed that conveyors are used for the transfer of beef carcasses, wherever these are suspended from overhead rails. By using conveyors it is always possible to have an even distribution of carcasses throughout the killing floor and to regulate the speed at which it is desirable to perform the work. They will also help to eliminate congestion and delay on the killing floor when inexperienced or less efficient labor is employed.

By referring to the plan, Figure 28, the process of cattle killing can easily be followed. The animals are driven into the knocking pens, which are built to hold two cattle in each pen. The knocker stuns the cattle and operates the hoist, which raises the knocking pen gates and floor. The carcasses are thereby rolled out on the killing floor, where they are shackled and hoisted to the bleeding rail. This rail is placed 15 feet above the floor level and runs alongside of a conveyor, which extends the full length of the room. The man who does the sticking stands near the knocking pens so that the cattle are thoroughly bled when they are at the lower end of the rail. At this point the head is taken off and thrown on the inspection table at

the other side of the rail. The conveyor now makes a turn and pulls the carcass to the drop-off rails in front of each

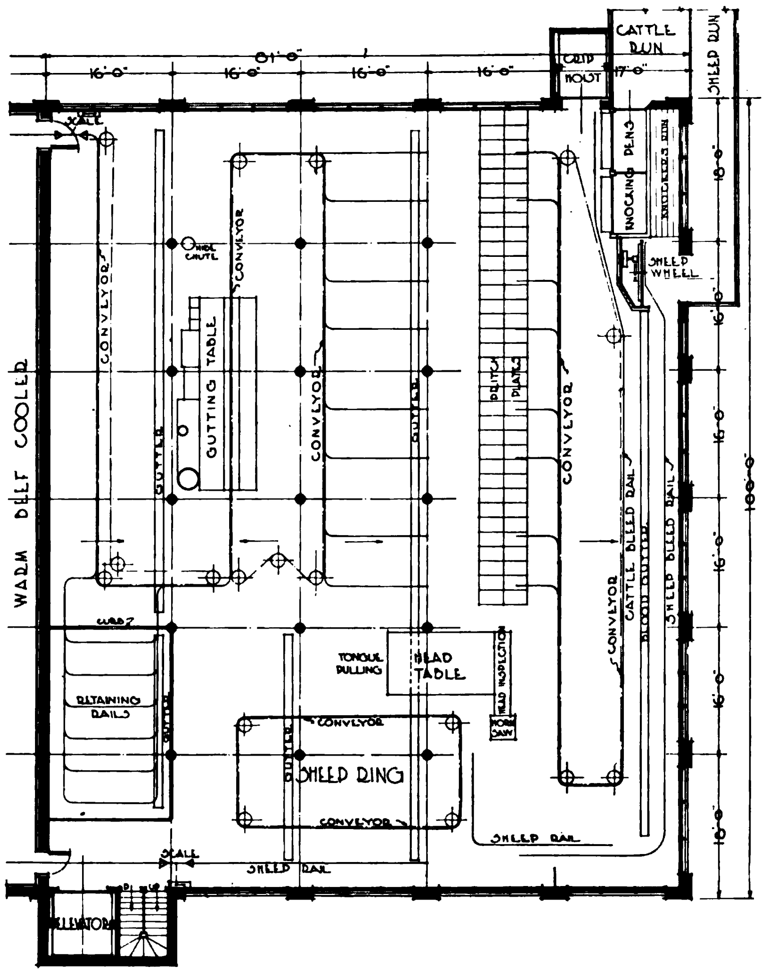


FIG. 28—BEEF AND SHEEP KILLING FLOOR.

bed. From here they are lowered to the floor by a friction hoist and pritched up for the floor work.

The hide dropping, gutting and splitting is done on the dressing conveyor, in the rear of the beds. The hide is

dropped before the carcass reaches the gutting table. This table or bench is about 24 feet long and is placed on hydraulic jacks so that it can be easily and quickly raised and lowered to suit the size of the carcasses which are handled. The last conveyor brings the finished carcass to the scale in front of the door leading to the cooler. All carcasses which are retained by the Government inspectors are hung in the retaining room to await the final inspection.

The sheep killing arrangement includes a wheel hoist which is placed in the catch pen adjoining the cattle knocking pens. The sheep are shackled and hoisted to the sticking rail and are thoroughly bled by the time they reach the

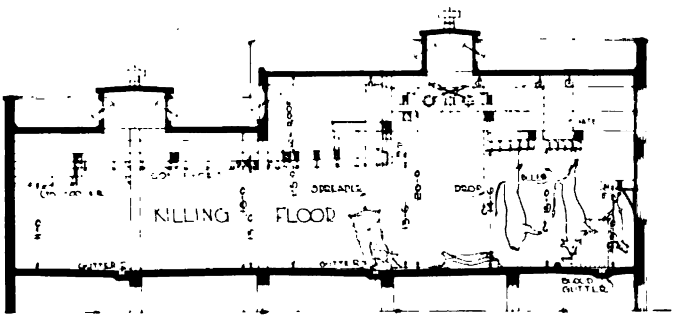


FIG. 29—SECTION THROUGH KILLING FLOOR.

end of the rail. From the bleeding rail they are transferred to the legging rail and from there to the dressing conveyor, where they are skinned and dressed. They are then hung on sheep logs, weighed, and run into the cooler.

The principal rail heights are given in the Section, Figure 29, which also shows the manner in which the killing floor is lighted and ventilated.

The construction is of reinforced concrete with the exception of the timber framing for rails and machinery.

Details of Cattle Killing Floor

In Figures 30 and 31 is illustrated in detail the arrangement of the cattle killing floor of the plant, which was described in Chapter III. Before the animals are slaughtered they are kept in the large resting-pens, outside of

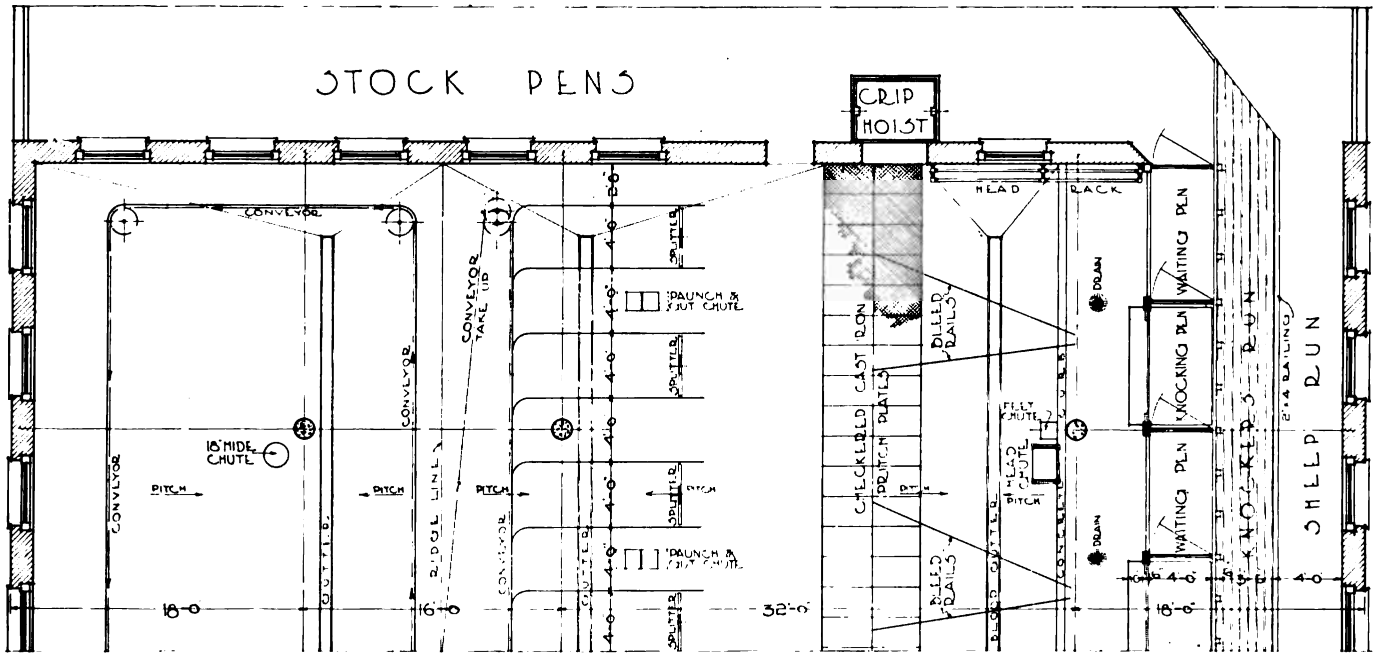


FIG. 30—FLOOR PLAN BEEF KILLING FLOOR.

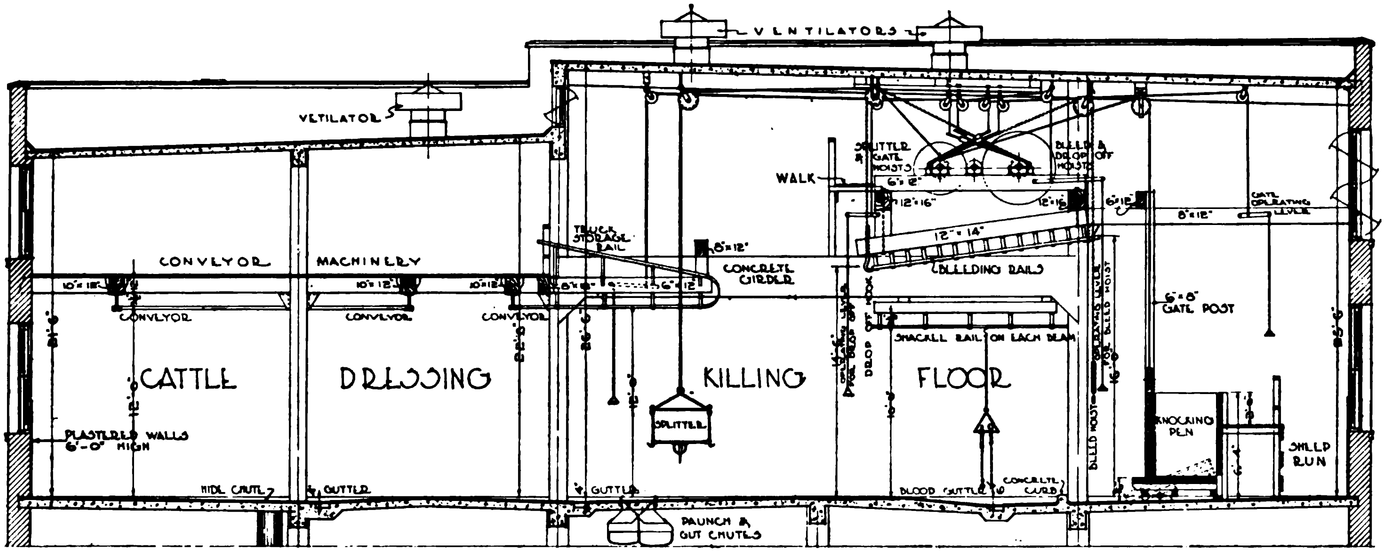


FIG. 31—SECTION THROUGH BEEF KILLING FLOOR.

the building, and are then driven into the knocking pens, in front of each killing bed. These pens are four feet wide and eight feet long and will accommodate two cattle (see detail in Fig. 32). Where single knocking pens are used they should be made only three feet wide, so that the animals cannot turn around in the pen. After the animals have been stunned they are rolled out on the killing floor by the raising of the front gate and the pivoted floor. They

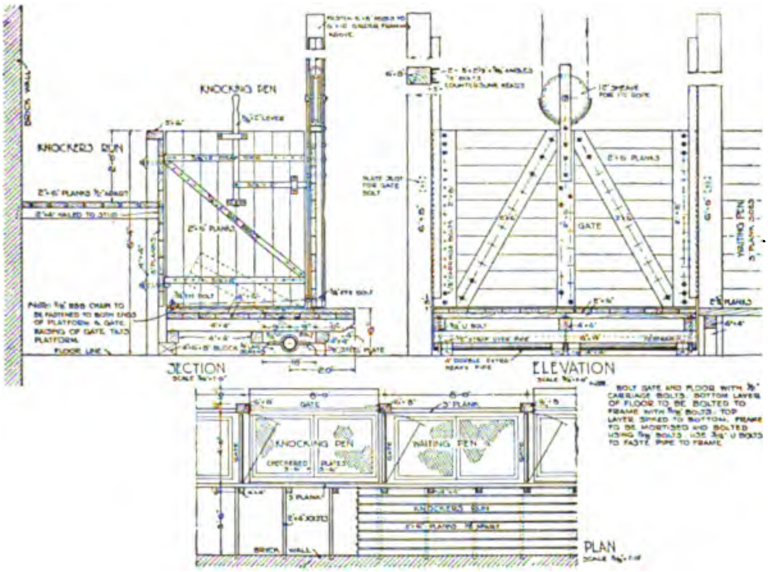


FIG. 32—DETAIL OF KNOCKING PEN.

are then hoisted to the inclined bleed-rails by a friction hoist, placed above the rails, and suspended until all blood has run out. The rail is supported by heavy cast-iron hangers which are bolted to a 12x12-inch yellow pine timber, suspended from the framework above. The cattle are lowered to the floor by the drop-off hoist and after the floor-work on the carcasses is finished they are hoisted by the splitting hoist to the wash rails, which are placed twelve feet above the floor level.

All hoists are of the friction type, with double wheels operating against a paper friction (see Fig. 33). The friction drum, 12 inches in diameter, runs at 200 revolutions per minute. The sizes of the wheels are 52x10 inches and 40x10 inches, with 8x12-inch drums, keyed to the same shaft. The larger wheels are used for hoisting and lowering the carcasses to and from the bleed-rail, and the smaller wheels operate the gates and splitting trees.

The hoists are driven by an electric motor and are operated by pulling a hand rope which raises a lever and brings the wheel in contact with the friction which starts the hoist. By dropping the lever, the action is discontinued

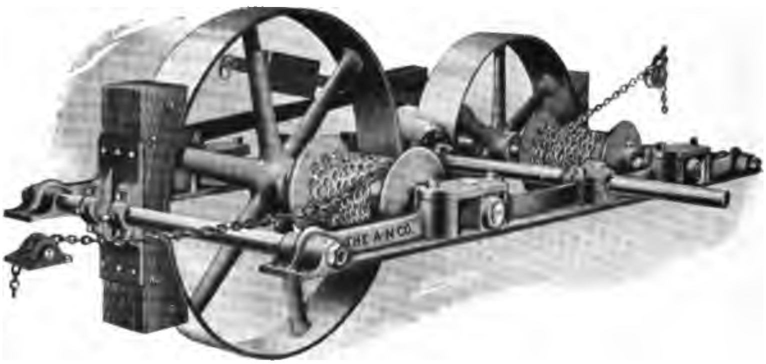


FIG. 33—FRICTION HOIST FOR BEEF KILLING.

and the hoist immediately stops. The action of the hand rope should be compounded by using an intermediate lever as illustrated in the sectional drawing. All hoisting sheaves should be fastened to heavy eye-bolts in the ceiling and the rope-sheaves suspended from 6x6-inch timbers bolted to the concrete roof slab. It is very important that all bolts be carefully and accurately located before the concrete is poured, so that the hoisting sheaves will come in the required location over the rails.

The washing and dressing of the carcasses is done on moving conveyors which are driven by an electric motor, placed on the frame-work above the killing floor.

All offal is dropped to the floor through separate chutes, which are built into the floor. The detail of the paunch and gut chutes is illustrated by Figure 34. Underneath these chutes are placed inclined galvanized iron troughs in which the guts and paunches slide to the cleaning tables on the offal floor. Heads and feet are dropped through holes in the killing floor and are cleaned and handled downstairs.

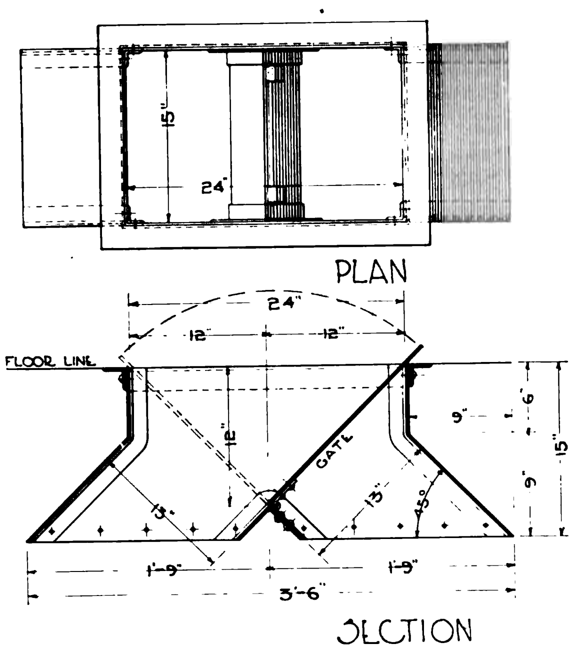


FIG. 34—PAUNCH AND GUT CHUTE.

The killing floor is lighted on all four sides by double rows of windows. The upper row of windows has double, pivoted sash, which are opened by an operating device arranged to open all the sash on one side at the same time. The large ventilators over the bleed-rails are made to open and close as may be desired.

The hatchway for the crip hoist, which is shown on the outside of the building, is used for the hoisting of crippled

cattle to the killing floor. The power is furnished by a friction hoist, which is operated from the same line shafts which drive the cattle hoists.

The section Figure 31 shows how the floor is pitched to the gutters. It will be noticed that there is a concrete curb placed alongside the posts in front of the knocking pens, to prevent any of the drainage waste on this part of the floor from reaching the blood-gutter.

The floor is paved with vitrified brick 4x8x1¼ inches thick, which are slushed and grouted with Portland cement. The floor is level for a distance of 6 feet where the floor-work is done, and pritch plates are built into it at the ends of the bleed-rails. These plates are 22 inches wide and 36 inches long and are made of 1-inch cast-iron with a checkered top-surface, to prevent the pritch from slipping.

Arrangement of Beef Offal Floor

In Figure 35 is illustrated an arrangement for the handling of beef offal on a large scale. This equipment is located on the floor directly below the killing floor and the offal is dropped through holes in the floor and conveyed by gravity chutes to the place where it is handled and cleaned.

The drawing shows in detail what equipment will be required to economically handle and convert all offal into a finished product, and illustrates how this equipment can be arranged to best advantage.

Hog Killing Arrangement

In Figure 36 is presented a sectional view of an arrangement for slaughtering hogs on a large scale.

The plan of this killing floor is shown in Figure 37. The plant is laid out for a capacity of 1500 hogs per day.

It will be noticed that the shackling pen, sticking pen and the scalding tub are all in a straight line, with the scraper at right angles to the tub and the moving-bench parallel with the tub. This makes a practical and convenient arrangement without crowding the equipment.

The hogs are driven into the waiting pens and from

there to the shackling pens, on either side of the double hog wheel. These pens are four feet six inches wide, which is about the maximum width for the convenient shackling of hogs. If the pens are made wider than this, the hogs will be so far away that the shackler cannot conveniently reach the wheel.

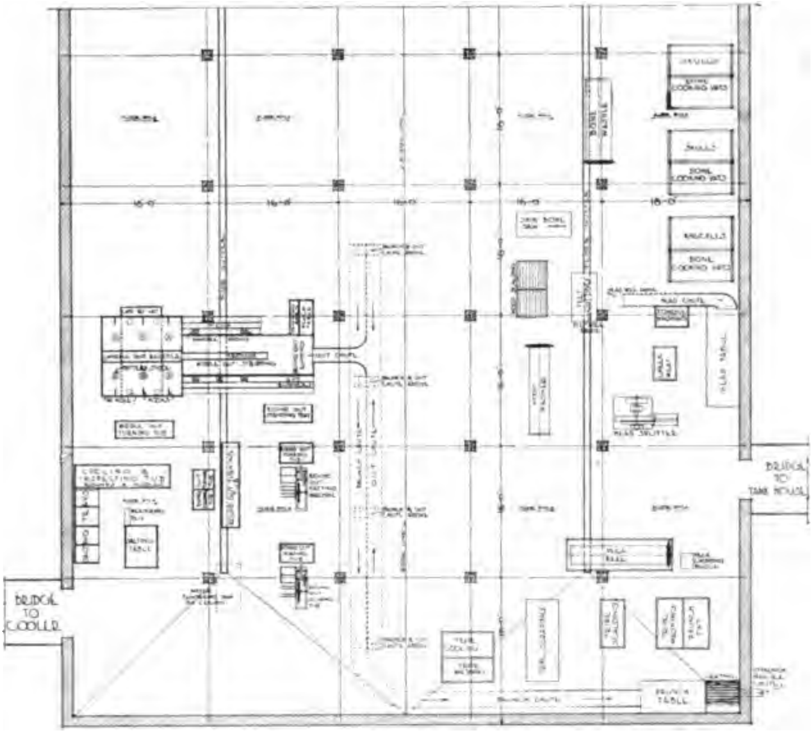


FIG. 35—PLAN OF BEEF OFFAL FLOOR.

The floor of the pen is eight feet above the main killing floor and the diameter of the hog wheel is 12 feet wide. This is set four feet off the floor, and the height of this part of the slaughter house must be 27 feet.

The hog wheel is operated by an electric motor, which drives also a friction hoist, used for picking up any hogs which may have dropped off the rail.

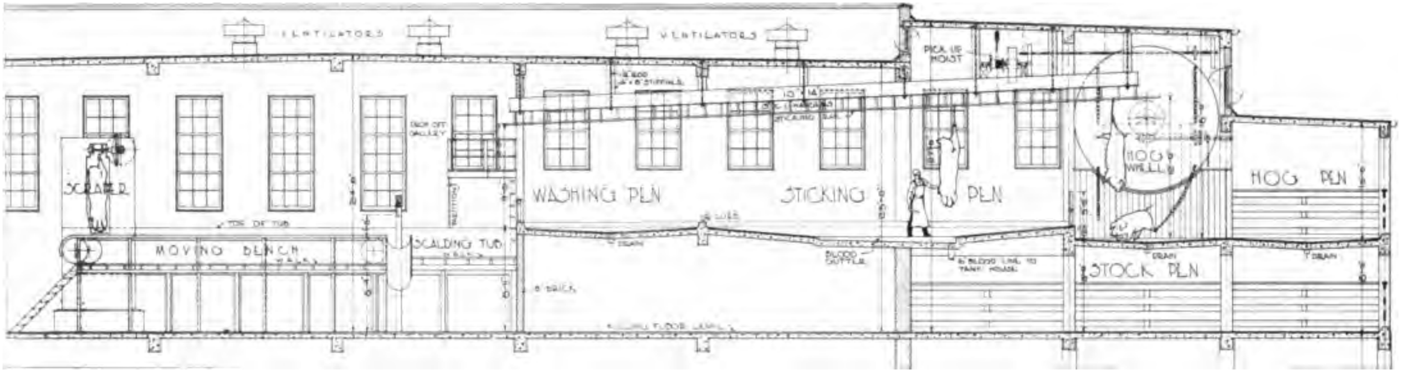


FIG. 36.

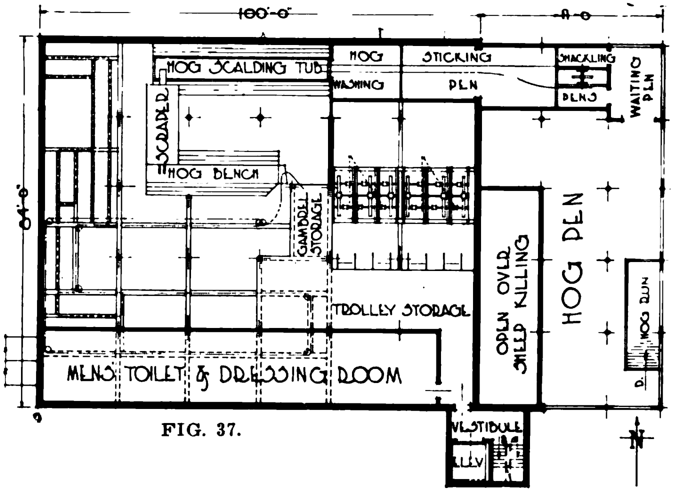


FIG. 37.

FIG. 36—SECTION THROUGH HOG KILLING FLOOR.

FIG. 37—FLOOR PLAN OF HOG KILLING ROOMS.

The sticking rails are 56 feet long with a three-foot incline from the wheel to the scalding tub. The rails are one and one-half inches in diameter and are fastened with cast-iron hangers to 10x14-inch yellow pine timbers. These are suspended from the concrete roof with one and one-quarter-inch rods on eight-foot centers. The floor of the sticking pen is divided by a concrete curb into two separately drained sections, one for blood and one for water. The blood is piped to the receiver in the tank house.

At the end of the sticking rail there is built a drop-off

FIG. 38—HOG SCRAPER—HORIZONTAL BEATER TYPE.

gallery above the scalding tub, where the shackles are returned to the pen as soon as the hogs are dropped off the rail.

The scalding tub is built of reinforced concrete and is placed so that the top of the tub will come eight feet eleven inches above the floor. This height is determined by the type of scraper to be used. In this instance, the scraper was an Allbright-Nell vertical machine of the beater type (Fig. 38). The size of the scalding tub is: Length, forty feet; width, five feet nine inches inside, and the depth is

three feet six inches. On each side of the tub is a plank walk for the use of the scalders.

When the hog is properly scalded it is picked up by the conveyor in the scraping machine and passed through a series of revolving beaters. The clean hogs are dropped from the conveyor at the delivery end of the machine onto the scraping bench. This is 28 feet long and four feet wide, with a moving top, supported on galvanized angle iron framework. The slats are made of maple and are fastened to a moving chain with roller bearings. The driving gear is located under the table and arranged with a direct drive from an electric motor. The top of the table is eight feet four inches above the floor and the gambrel rail is 20 inches above the rail, which gives a height of 10 feet for the hog dressing rail.

The hogs are kept moving on the rail by a conveyor which is arranged for a variable speed, so that the number of hogs killed per hour can be increased or decreased as desired.

The essential requirement of a hog killing floor is good light and ventilation. This can only be provided where the killing is done on the top floor, so that the ventilators or skylights can be built in the roof.

The Government recommends that the scalding tub and scraper be placed within a separate inclosure, so as to keep the steam away from the hog dressing floor.

Mechanical ventilation is generally installed in larger killing floors and the air is heated, during cold weather, before it is delivered to the ventilating ducts. This will most effectively remove all steam and vapors and will greatly improve conditions on the killing floor.

Hog Cutting Room

In Figure 39 is illustrated the arrangement of a hog cutting room with a capacity of 600 hogs.

These are brought in on the rail from the adjoining cooler and elevated by the inclined conveyor to the moving cutting table, where the hams are cut off. These are

thrown onto the ham table and trimmed and afterwards dropped through an opening in the floor to the curing cellar below. The remainder of the hog is carried to the chopping block and there cut up; the shoulders and sides slide on inclined chutes to tables on the floor, where they are

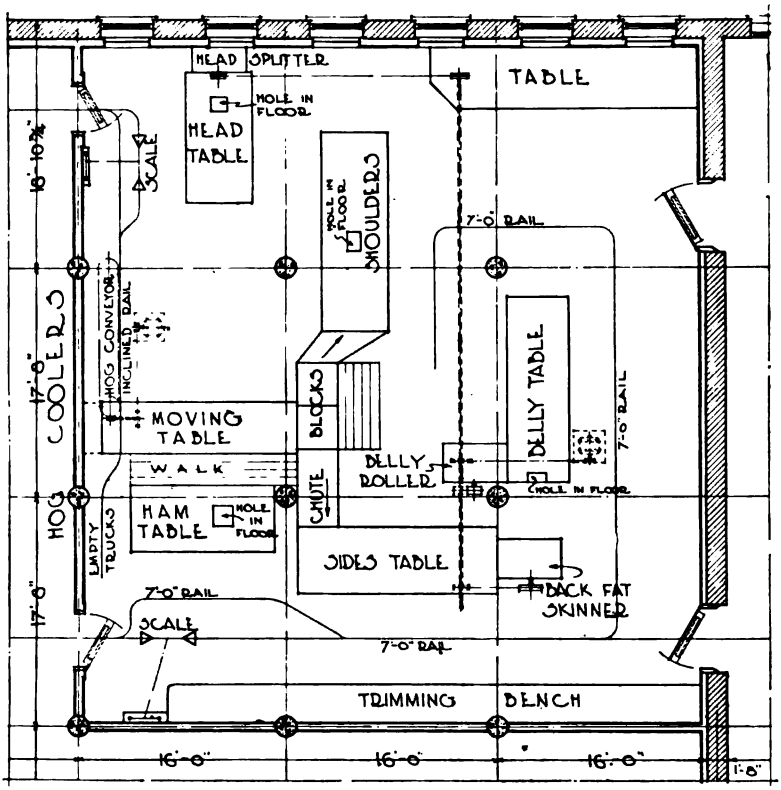


FIG. 39—PLAN OF HOG CUTTING ROOM.

made into their respective cuts, which are dropped to the curing cellar below. An overhead rail is placed alongside all tables for hanging off fresh pork cuts, which are run into the sales cooler.

The equipment includes a head splitter, belly roller and back fat skinner, which are operated from a counter-

shaft on the ceiling, driven by a 5-H. P. motor. The hog conveyor and cutting tables are driven by another 5-H. P. motor hung from the ceiling.

The cutting room is insulated with four inches of cork and all windows are made with a double thickness of glass. The room is not refrigerated except by the cold air which may leak through from the cold storage rooms above and below or from the adjoining hog coolers.

CHAPTER VII

PACKING HOUSE COOLERS

Cold storage in packing plants has heretofore largely been confined to such requirements as would take care of the chilling and curing of the output until ready for shipment. The growing use of refrigerated space by the packers is due to the advantages of having facilities on their premises in which to store their cured and frozen products over seasons. These commodities would otherwise be sent to a public warehouse and pay storage charges in addition to the expense of transfer and return shipment. By having sufficient cold storage room at the plant, the packer partly eliminates this expense and is able to increase his killing output at the time of the year when live stock is most plentiful and can be killed to the best advantage.

The cost of refrigeration is less to the packer than to the cold storage owner, since the engine room and overhead expense is partly absorbed by the plant operation. For this reason we find that many plants are in a position to store all of their own products, as well as other commodities, such as poultry, butter and eggs in season.

Cold storage in packing plants is more diversified from the standpoint of construction than is required in commercial cold storage buildings. The application of refrigeration to the various processes of meat handling requires cold storage facilities which must be designed so that the various products may be handled and stored according to the best packing house practice. Each kind of storage must be built so as to properly take care of the product dealt with.

It is not alone sufficient to provide for rooms with the proper temperature. It is equally important that the circulation and humidity of the air be such as will retain the appearance and quality of the meats and without undue shrinkage while it is kept in storage. The methods of handling the products will also enter into the details of construction in order to provide the necessary equipment and facilities required in each kind of storage.

This chapter will be devoted to special requirements pertaining only to packing house coolers. The general features of cold storage construction are set forth in detail in later chapters and the reader is therefore referred to that part of the book for all information regarding the proper construction of walls, floors, insulation, etc.

Principle of Construction in Beef and Hog Coolers

A perfect circulation of the air is the most important requirement in coolers where warm meat is hung for chilling. When the carcasses of beef and hogs are brought to the coolers from the killing floor, the animal heat must be removed as rapidly as it emanates from the meat. Unless this is done, the moist vapors which are produced by the rapid chilling of the hot meat will condense on the walls and ceiling of the cooler, and the air, instead of being pure and dry, will become foul and saturated with moisture. This affects not only the quality of the meat, but makes it slimy and unattractive in appearance.

In order to provide a proper circulation of air, it is necessary to build a refrigerating loft above the cooler, with an arrangement of ducts and openings which will furnish a natural gravity circulation. The air must be removed from below and passed over the cooling coils before it again reaches the hanging room.

This arrangement is illustrated in Figure 40. The warm air duct along the wall acts as a chimney and draws the warm air and vapors rising from the meat, up to the loft above, where it circulates among the cooling pipes and condenses and parts with its moisture. The heavier cold

air, now dried and free from moisture, falls through the cold air duct on the other side of the room, thereby producing a natural gravity circulation.

The arrangement of coolers and pipe lofts is fully illustrated in the plans and sections of packing house plants, shown in the preceding chapters.

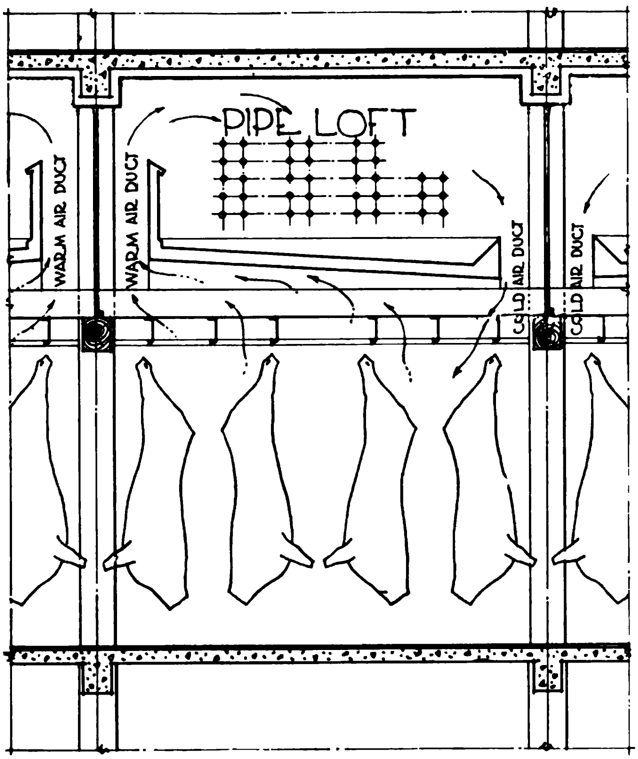


FIG. 40—SECTION SHOWING AIR CIRCULATION IN COOLER.

Refrigerating Lofts Over Beef Coolers

In Figure 41 is indicated the construction of a refrigerating loft over beef and sheep coolers. The floor is supported on 6x12-inch yellow pine joists, which also carry the hangers for the beef rails. The 3x3-inch wood strip, laid over the joists, is cut out for the bolt-heads in order

to give room for tightening up the hanger bolts. The construction above consists of a beveled nailing strip, over which is laid an insulated floor or drip pan. The beveled strip is put in to provide an 8-inch slope for the floor to the drain outlets and it also gives a similar slope to the ceiling of the cooler so that the air will circulate more freely towards the warm air ducts.

The floor is constructed with one layer of ⅝-inch V-groove boards, nailed at each bearing; over this is laid

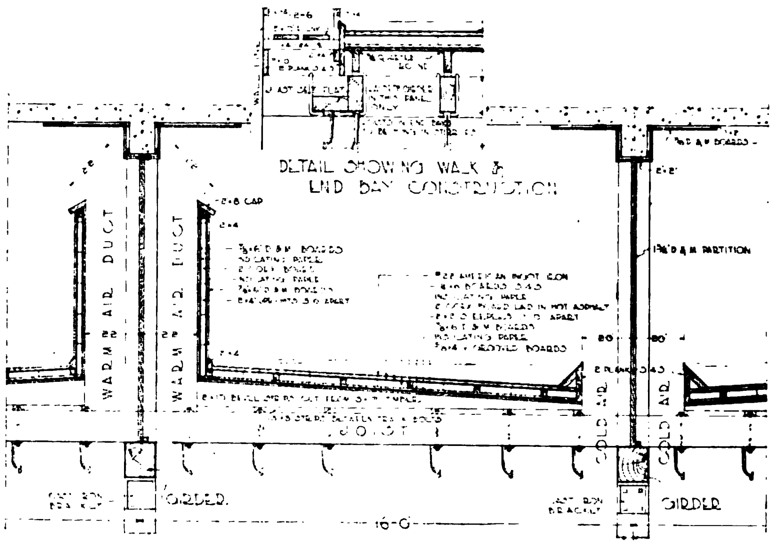


FIG. 41—DETAIL OF PIPE LOFT FOR BEEF COOLER.

one thickness of waterproof insulating paper and ⅞x6-inch dressed and matched flooring. This is covered with two inches of corkboard, laid in hot asphalt and finished with 1¼x6-inch surfaced lumber, securely nailed to the 2x2-inch nailing strips, laid between the cork boards. The floor is covered with a galvanized iron pan of No. 22 American ingot iron, which is put down to make an absolutely watertight floor. It should, therefore, be very carefully laid, with soldered joints, and thoroughly tested out.

At one end of the pipe loft there should be provided a walk for convenience in operating the valves on the refrigerating coils. The floor and air ducts are stopped within 30 inches of the wall and a 2-inch plank curb put up along the edge of the pan, to prevent any water from spilling over the sides. The walk is laid with 2x10-inch planks, placed two inches apart. These openings will provide an increased circulation of air along the wall in the cooler and will be found to be of great advantage, on account of the stopping of the air ducts above, at this point.

The partition for the warm air duct is constructed with 2x4-inch studding placed three feet apart. Each side of the studs is covered with one layer of insulating paper and one thickness of ⅞x6-inch dressed and matched boards. The space between the studding is filled with two inches of corkboard, put up with all joints sealed with hot asphalt.

The partition is capped with a 2x8-inch beveled plank, placed at the same distance from the ceiling as the width of the air duct. Where ceiling beams or other obstructions would interfere with the proper circulation of the air, the partition should be placed so as to leave a full opening at all points of the duct. When there is cold storage above it is not necessary to insulate the ceiling over the pipe-loft. There is a tendency, however, for moisture to condense on an uninsulated ceiling whenever there is a difference in the temperature on two floors and this is frequently the condition in coolers when warm beef is put in. The slight drip from the ceiling would only be annoying over the openings in the air ducts, since the floor of the coil loft is watertight.

In order to overcome this defect, the ceiling over the air ducts should be covered with ⅞-inch yellow pine boards which are nailed to 1x2-inch cleats, fastened to the ceiling.

Pipe-Lofts Over Hog Coolers

Hog coolers are divided into sections or tunnels by placing partitions between the posts. These are generally

spaced 16 feet on centers, which provides room in each cooler for six hanging rails.

The partitions should be insulated with two inches of corkboard or other material of equal insulating value and should extend from the floor of the cooler to the ceiling of the pipe-loft. The arrangement of the air ducts in hog coolers must be different from that of beef coolers, on account of the greater amount of warm meat which is placed in the hog coolers at one time. The warm air and

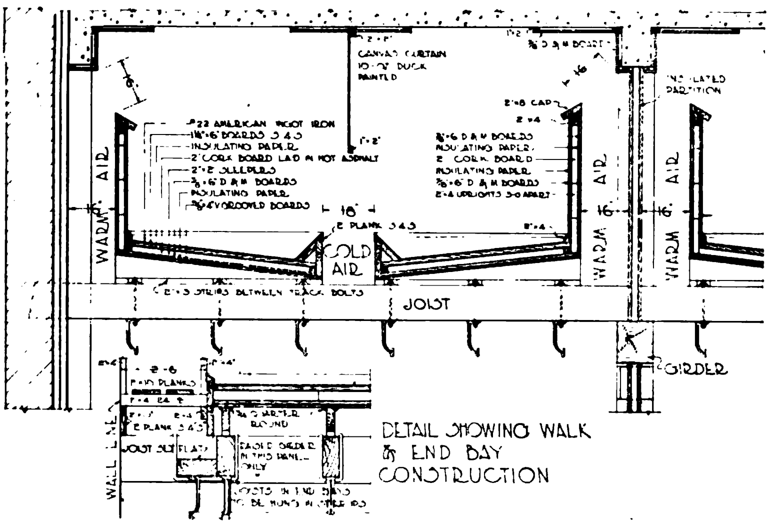


FIG. 42—DETAIL OF PIPE LOFT FOR HOG COOLER.

vapors must be cooled off more rapidly than in beef coolers and an increased circulation of air and more refrigerating pipes must be provided.

In Figure 42 is illustrated the construction of the pipe-loft. Two warm air ducts, 16 inches wide, are placed one on each side of the room and a cold air duct, 18 inches wide, in the center. With this arrangement of ducts, the air need only travel one-half the width of the cooler before it reaches the warm air flue to the pipe-loft.

The construction of the floor and partitions is similar to that described for beef coolers and the illustration is sufficiently clear to explain everything in detail, so that no further description will be given.

The canvas curtain which is placed over the center of the cold air duct is put in to deflect the air downwards, after passing over the cooling pipes.

Detail of Refrigerating Loft for Spray System

In Figure 43 is indicated the construction of a refrigerating loft where brine is sprayed through the room to cool the air in the hog cooler below. These are made two sections wide, with dividing partitions at every other post line, and are arranged with one cold and one warm air duct,

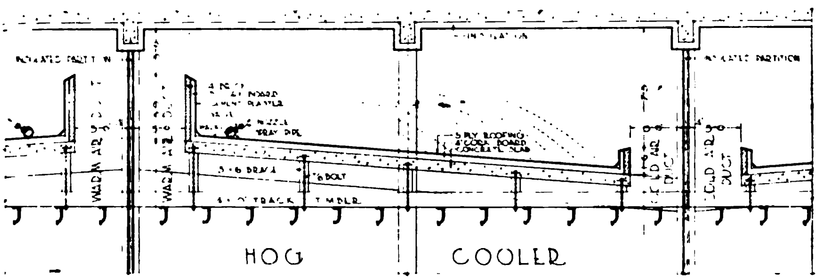


FIG. 43—BRINE LOFT FOR SPRAY SYSTEM.

at opposite sides of the cooler. A gravity circulation is created by the movement of the air in the loft towards the cold air duct and a corresponding movement of air in the cooler towards the warm air duct.

The concrete floor or drip pan is built with an incline of two feet and is insulated with four inches of corkboard, laid in hot asphalt pitch. The finished surface is made waterproof with 5-ply roofing felt, applied with odorless roofing pitch.

The partition for the warm air duct is built of 4-inch brick or hollow tile and is insulated with three inches of corkboard, which is finished with Portland cement plaster. The construction is fireproof throughout except for the

4x10-inch timbers which support the hog-rails in the cooler. These supports could be made of structural steel in case it would be desirable to entirely eliminate wood in the construction.

Curtain System of Refrigeration

In Figure 44 is indicated a system of exposed brine

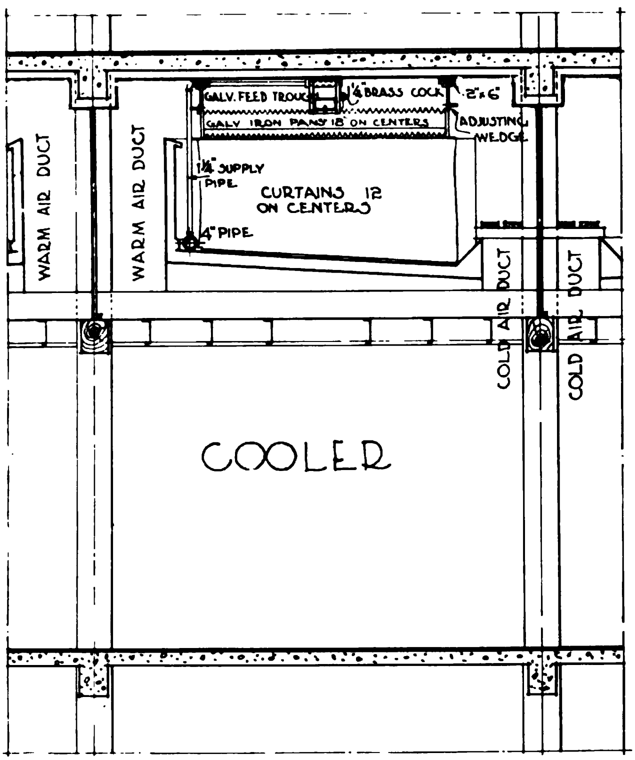


FIG. 44—GARDNER'S CURTAIN SYSTEM.

circulation patented by Mr. H. C. Gardner, of Chicago, Ill. This system has been used in some of the largest plants in Chicago. The principle of operation is as follows: In the refrigerating loft above the cooler is hung a series of curtains, or cloths, suspended from the ceiling. Over each

curtain is placed a brine trough which is filled with cool chloride of sodium brine. This overflows the trough and trickles down over the cloth to the floor below. The warm air from the cooler comes in contact with the cold brine and is chilled and purified before it passes down through the cold air ducts at the opposite side of the bunker.

Mr. Gardner makes the following statement regarding the adaptability of his system for packing house refrigeration:

"Experience has shown that the vapors coming off the warm product are rapidly absorbed, and the air is maintained at the most desirable state of humidity; that there is rapid refrigeration without undue drying, and that the air is largely purified by coming in contact with the wet surface of the sheets."

Temperatures in Beef Coolers

When the beef is brought to the cooler from the killing-floor, it is first placed in the fore cooler, or warm beef chill room, where the temperature should be from 45° to 48° Fahr. This temperature is maintained until the killing is finished and the refrigeration is then turned on in all coils, so as to bring the temperature down to 38° Fahr. This should be accomplished in about 12 hours' time, so as not to chill the beef too rapidly. The beef is then taken to the storage cooler and hung in a temperature of 34° to 35° Fahr. until shipped.

Temperatures in Hog Coolers

The usual practice in hog coolers is to have the rooms at a temperature of 30° Fahr. when the hogs are run in from the killing floor. The temperature will quickly rise as the number of warm hogs increases, but it should not be allowed to rise about 45° Fahr. When this temperature is reached, the door should be closed and the remaining hogs run into the next cooler, until the temperature in the first cooler begins to go down. The following card gives the proper temperature for chilling hogs until they are ready for cutting:

Fill Cooler 30° to 32° Fahr.	Temperature Hams-108F.
Temp. Cooler at 11 P. M. same day 34F.	Temp. Hams-44 to 46F.
Temp. Cooler at 7 A. M. next A. M. 32F.	Temp. Hams-40 to 42F.
Temp. Cooler at 7 P. M. next P. M. 30F.	Temp. Hams-34 to 35F.
Temp. Cooler at 7 A. M. 2nd Day 28F.	Temp. Hams-32 to 33F.

When the hogs are not cut within 48 hours after killing the temperature of the cooler should not be below 31° Fahr.

CHAPTER VIII

TANK HOUSES

The designing of tank houses, or rendering plants, as they are frequently called, requires a thorough knowledge of the equipment which is needed to operate these plants. The building must be designed around the equipment, so to speak. The size of all tanks and machinery should be decided upon and laid out to scale on the drawings before the construction work is started, so that the necessary supports and openings in the floor can be properly provided for at the time the building is erected.

As tank houses are considered one of the greatest fire-risks among packing house buildings, and since they carry the highest basis rate of insurance, they should be built fireproof and the recommendations of the Board of Underwriters complied with in all parts of the construction.

Sanitary conditions in a tank house are, at their best, far from satisfactory, on account of the nature of the business. The construction and equipment should, therefore, include all the features and improvements which will assist in keeping the building clean and odorless.

The floors must be of impervious materials and laid with good drainage to the sewers. The walls should be plastered with cement mortar for at least four feet above the floor line and given a hard, smooth surface which can be washed down and kept clean.

Light and ventilation should be provided for on as many sides of the building as the arrangement of the plant will permit and if ventilating flues are built in the walls, they will materially assist in carrying off the steam and odors.

The equipment should include vapor condensers for all tanks and driers, and these must be operated continuously during the hours of cooking and drying.

The health department in many cities does not permit the operation of tank houses within the city limits unless

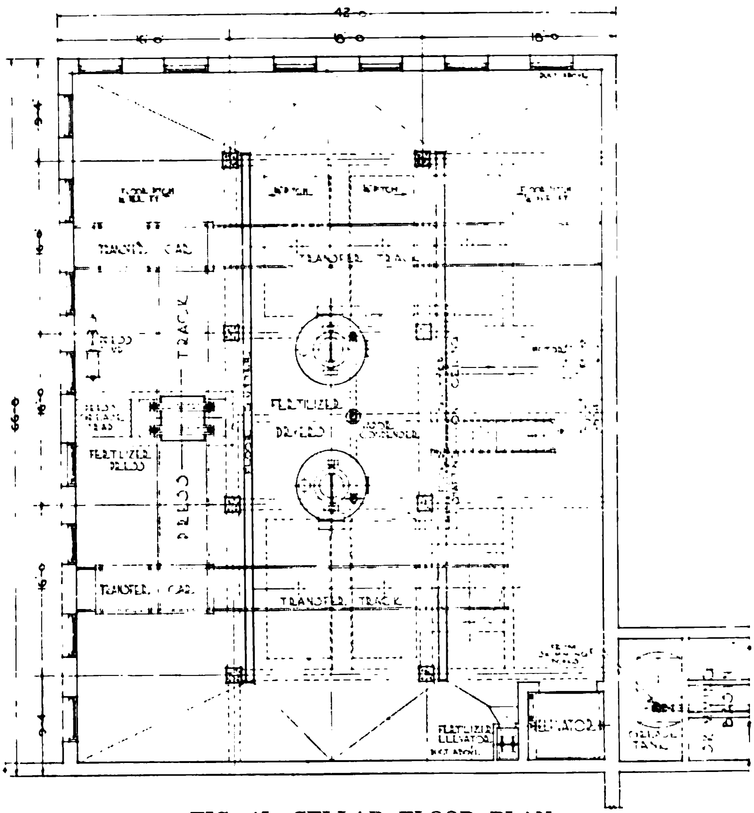


FIG. 45—CELLAR FLOOR PLAN.

precaution is taken to eliminate the odors. They require that all windows and doors be kept closed and insist upon a system of mechanical ventilation whereby the air is exhausted from the building and discharged into the lower end of an air-washing tower. The construction of this tower must be such that the air will be washed and purified

by passing through a continuous spray of water before it reaches the outside atmosphere.

In Figures 45 to 48, inclusive, is illustrated the arrangement of a modern fireproof tank house, designed to handle edible and inedible products, under Government supervision.

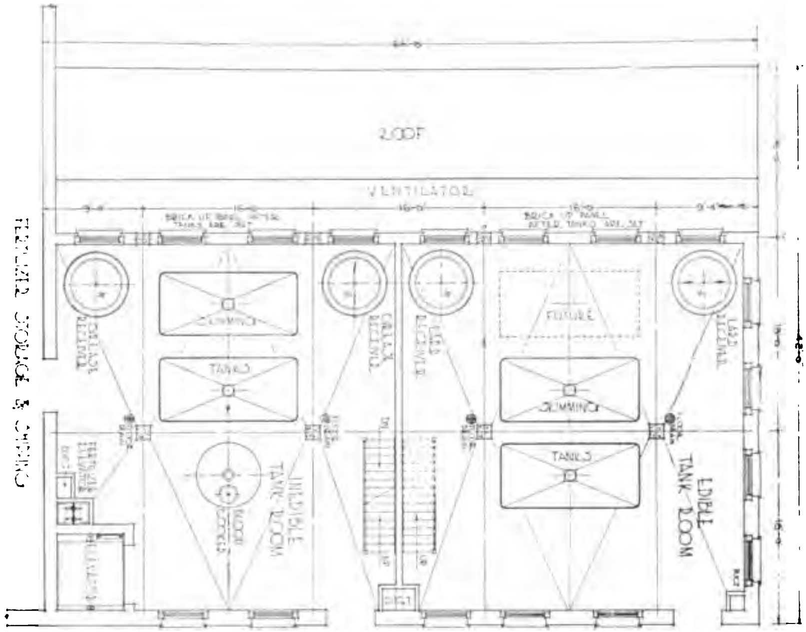


FIG. 46—FIRST STORY FLOOR PLAN.

The building is three stories high, with a cellar, and is divided by an 8-inch brick wall into two sections above the first floor. On one side is the edible department and on the other the inedible is located.

There is no direct connection between the two departments; separate stairways are provided and all entrances to the rooms are from the outside. The cellar is undivided and is used for the pressing and drying of fertilizer. The building is located adjoining the fertilizer storage and has

light and ventilation on three sides. Covered bridges on the third floor connect with the offal department and the meat trimming room, which are located on the third floor of the adjoining buildings. The construction is of reinforced concrete with brick walls. The floors are finished with cement mortar and pitched to the drain outlets with a slope of one-fourth of an inch per lineal foot. The walls are plastered below the window sills, which are placed four feet above the floor.

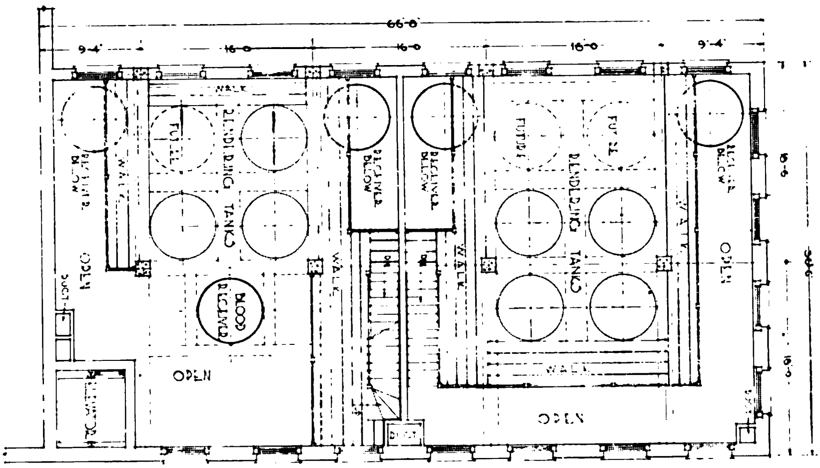


FIG. 47—SECOND STORY FLOOR PLAN.

In order to provide open spaces for light and ventilation around the rendering tanks, the second story floor is omitted with the exception of a narrow walk on each side of the tanks.

This arrangement gives a high unobstructed cooking room with a double row of windows, and these, together with the large ventilating flues shown in the ceiling, will carry off the steam and odors from the cooking.

The size of the building can be increased by removing the temporary brick wall at the east end. This would leave the wall columns and beams exposed and these are designed to support the load from the new part of the building.

The equipment in the edible department consists of four rendering tanks, two open skimming boxes and two open lard receiving tanks.

The inedible department is equipped with four rendering tanks, two skimming boxes, one blood storage tank, one blood cooker and two grease receivers. All tanks are built of steel, riveted and caulked.

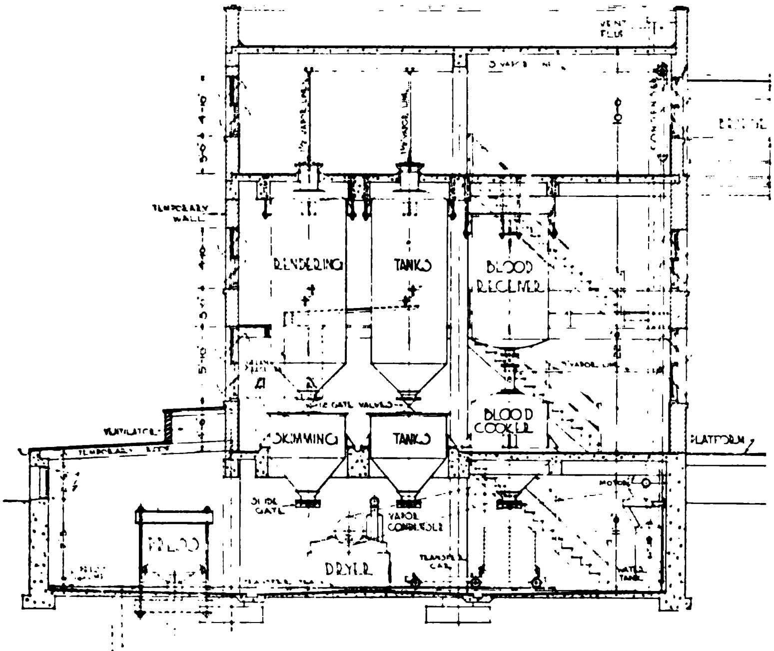


FIG. 48—SECTION THROUGH TANK HOUSE.

The machinery shown on the cellar plan consists of one hydraulic fertilizer press with pump, double press-car, two transfer cars and the necessary floor tracks. There are also two rotary fertilizer driers with electric motor and vapor condenser.

The rendering tanks are filled on the third floor and the contents cooked under forty pounds steam pressure for about ten hours.

When the pressure is off, the tank is allowed to settle and the lard or grease is drawn off into the receiving tanks on the first floor. The remaining residue in the bottom of the tanks is dumped into the skimming boxes below and left to settle. The lard and grease is then skimmed off the top and sent back to the rendering tanks to be recooked. The tankage left in the skimming box is removed from the bottom of the box and placed on heavy burlap cloth, laid between wooden racks on the press carriages. When the press is filled, the tankage is pressed to bring out the water and remaining grease and afterwards dried in the fertilizer driers.

The tank water from the rendering tanks, skimming boxes and press is collected in the storage vats outside the building, where all of the remaining grease is skimmed off before the water is pumped over to the evaporators, located in the fertilizer building.

In Figure 49 is illustrated the construction of a rendering tank with a cast iron head. This type of head has been patented and can be purchased from the patentee for a nominal sum.

The advantage of having the tank built in this manner is evident to all who have used the old style of tank with dished head extending above the filling floor. These tanks rusted out very rapidly where they came in contact with the floor construction and the upper part had to be renewed long before the rest of the tank was worn out. With the cast iron head the main body of the tank is below the floor construction and allows the air to circulate around the tank.

The small space occupied by the cast iron head on the filling floor leaves more room to work around the tank and less opening for seepage water to find its way down along the sides of the tank. This is always objectionable, as the odor from dirty water, steaming on the hot tank, is very offensive.

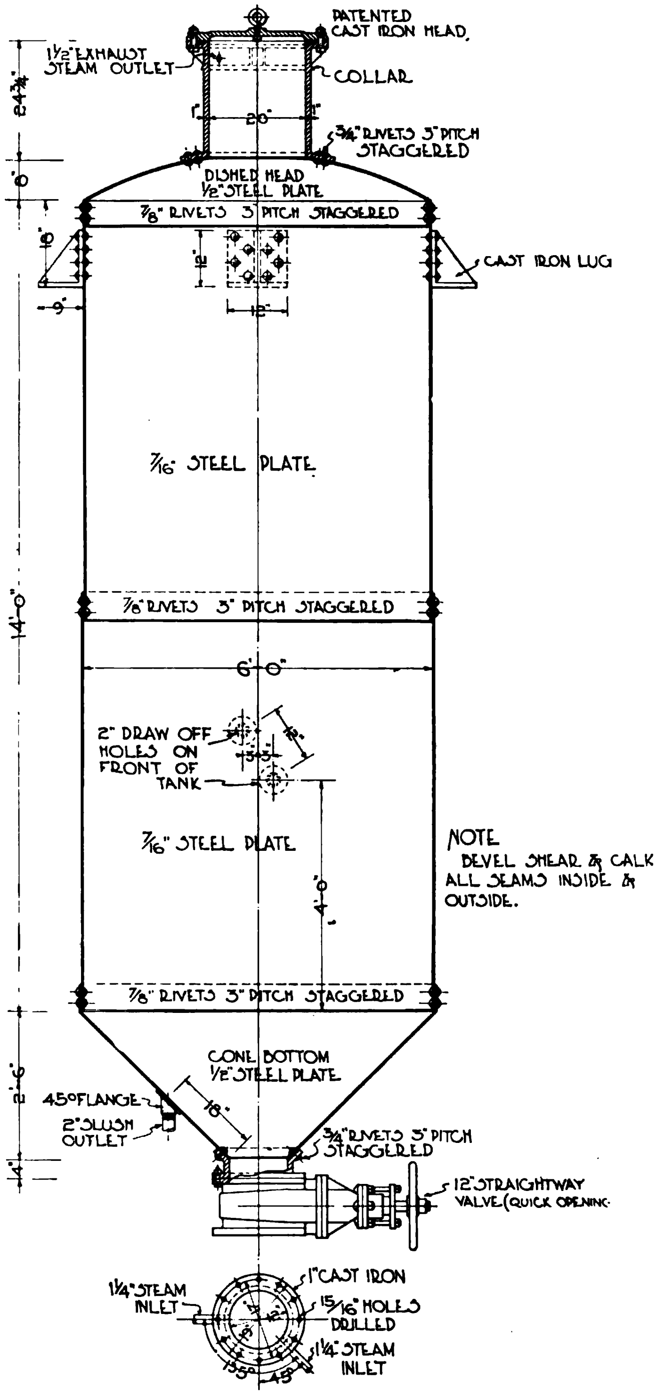


FIG. 49—DETAIL OF RENDERING TANK.

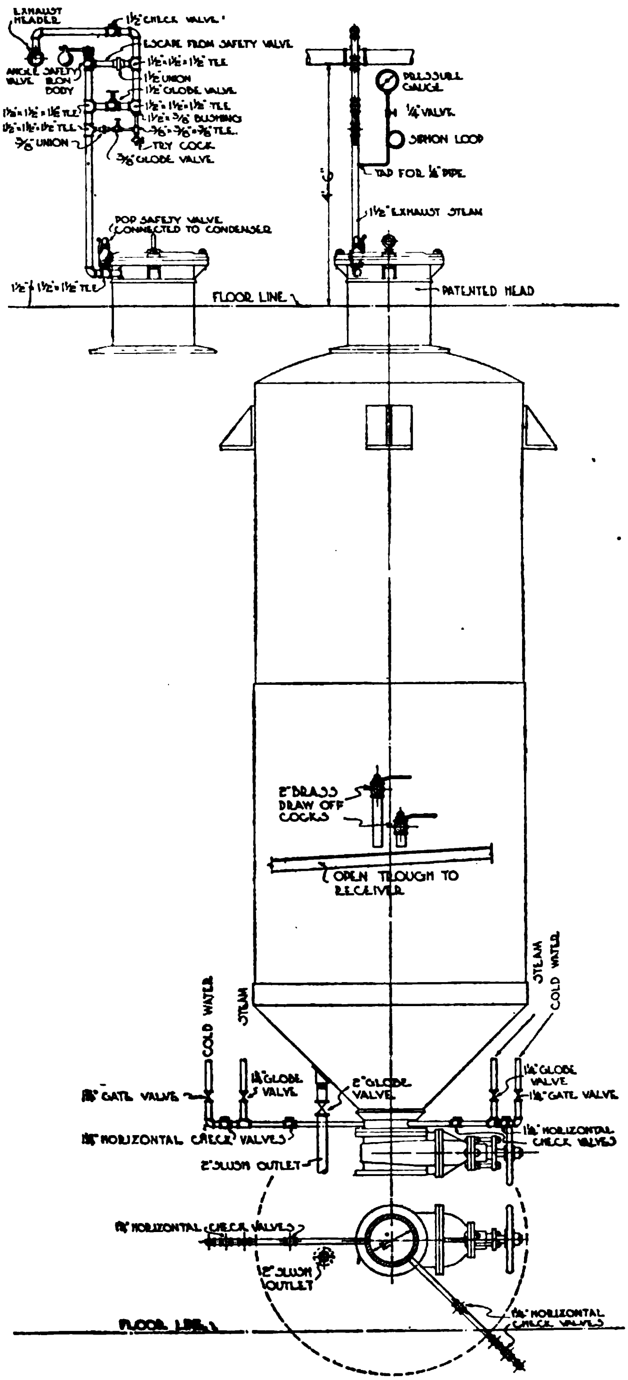


FIG. 50--RENDERING TANK WITH PIPE CONNECTIONS.

In Figure 50 is illustrated a rendering tank with the necessary pipe connections, valves and fittings for complete operation.

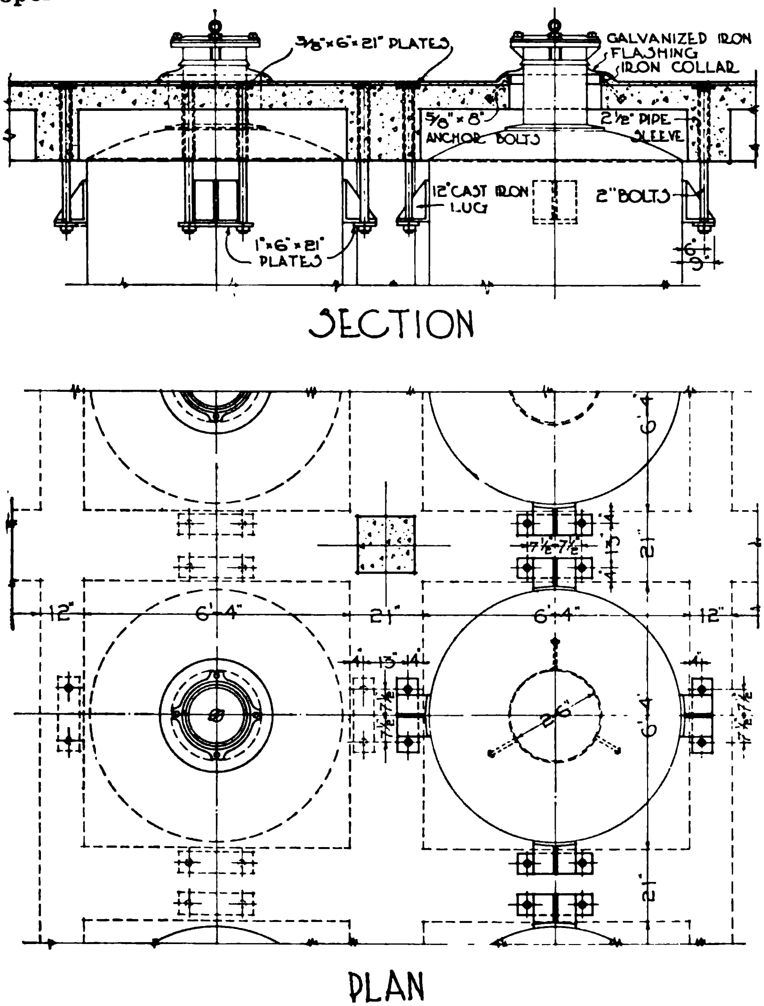


FIG. 51—DETAIL OF SUPPORTS FOR SUSPENDED RENDERING TANKS.

In Figure 51 is illustrated the method of suspending the rendering tanks from the concrete floor construction above.

The tanks are carried by eight 1¾-inch diameter bolts, made from genuine wrought iron. The lugs on the side of the tanks rest on the steel bearing plates between each pair

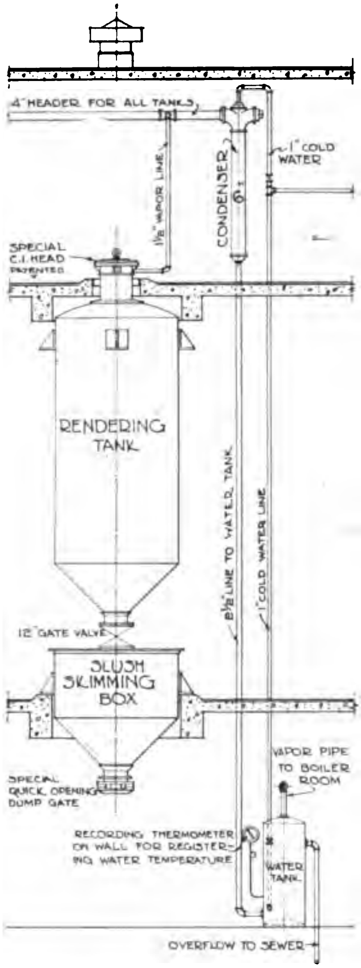


FIG. 52—VAPOR CONDENSING SYSTEM FOR RENDERING TANKS.

of bolts, and these plates should not be placed until the tanks are hoisted into position. The pipe sleeves around the bolts are built in the concrete. The bolts are placed after the floor is laid and the concrete floor finished over

the bolt heads. If the bolts rust out and have to be renewed, they can be easily pushed up through the cement finish and the new bolts slipped into place. The margin of safety is about 40 to 1, for the ordinary size tank, when filled. The ring around the opening in the floor, where the tank passes through, is anchored to the concrete with ½-inch bolts and a curb formed around the opening. After the tanks are erected, the space around the cast iron head should be flashed with a galvanized iron collar in order to prevent the water on the filling floor from seeping through.

In Figure 52 is illustrated a vapor condenser used for condensing the steam from the rendering tanks and blood cooker during the time of operation. Separate condensers must be used for each department.

The drop leg of the condenser terminates in a sealed water receiver and the odors which are not absorbed by the water are carried off to the grates of the boilers and escape through the smoke stack. The overflow pipe from the water tank is connected with the sewer and a self-recording thermometer is placed on the tank to register the temperature of the water which is used for condensation. In Chicago the records of the thermometer must be filed with the Health Department.

In Figure 53 is illustrated the construction of a skimming box with a sliding gate for removing the tankage. These gates are especially made for this purpose and can be purchased from packing house supply dealers in Chicago.

In Figure 54 is illustrated how the track for the fertilizer press is placed on the cellar floor. The press car and the transfer car run on 20-pound rails bolted to iron carriages which are imbedded in the concrete floor.

The height of the rails will be governed by the height of the press platform and the transfer car. However, the low rail should be at least one and one-half inches clear of the floor, so that the water will pass under the rails when the floor is cleaned up.

The blow tank, shown on the cellar floor plan, is a closed steel tank built for a pressure of 25 pounds per square inch and is placed in a pit below the cellar floor.

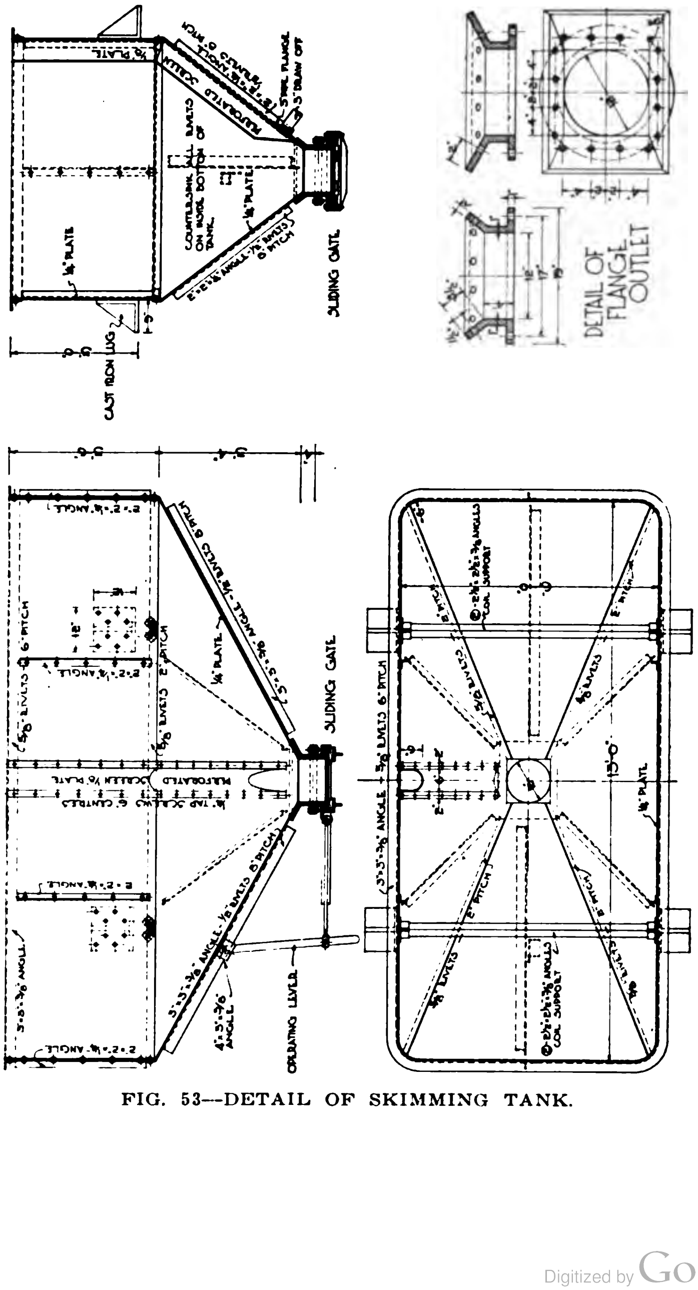


FIG. 53—DETAIL OF SKIMMING TANK.

This tank is used as a receptacle for the grease from the skimming basin. When the tank is filled, the valve on the receiving line is shut, steam pressure is applied to the tank and the skimmings blown up to the inedible rendering tank, where they are cooked.

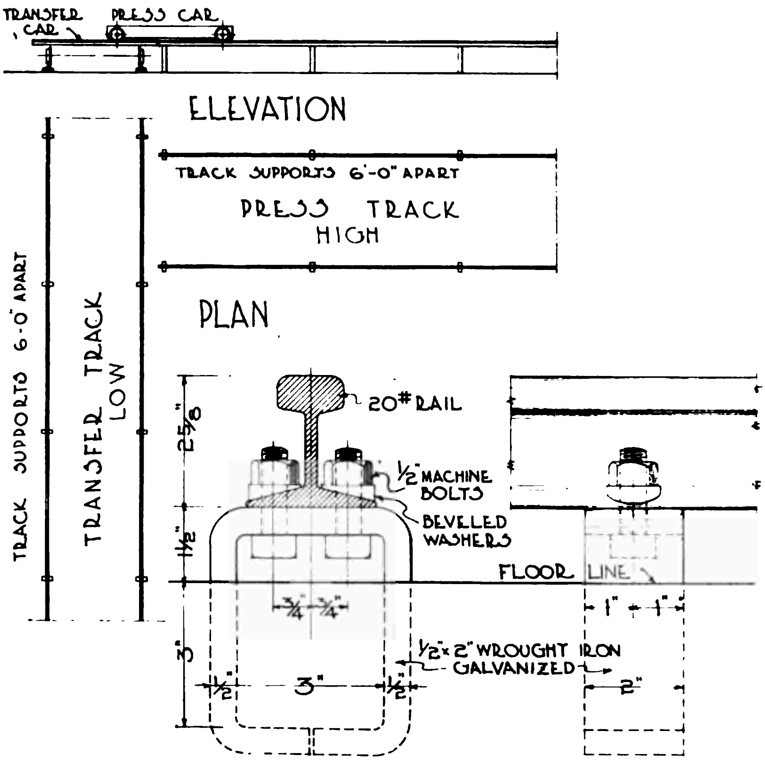


FIG. 54—DETAIL OF TRACKS FOR FERTILIZER PRESS.

A similar arrangement can be installed for the lard which is skimmed off from the skimming boxes in the edible department. The tank can then be set directly on the cellar floor. The skimmings are sent back to the edible rendering tanks to be recooked.

CHAPTER IX

SMOKE HOUSES

Meats are preserved and made more palatable by being exposed for a certain length of time to the smoke from wood fires. In the olden days the smoke house was a part of every large household and hams and bacon were cured and smoked much in the same manner as in the modern packing house of today.

The principal change will be found in the method of hanging the meat. In the old-style smoke house wooden sticks were placed from wall to wall and the meat was hung in tiers, one above the other, until the house was filled. This method has been discarded for the more convenient system of using portable meat trolleys, suspended from overhead rails. By extending these rails to the soaking vats and to the hanging and packing room the meat can be transferred on trolleys from one room to another.

A further advantage of the trolley system will be found in the improved appearance of the meat, since it avoids handling by hand, which always makes meat greasy looking and takes away its bright, attractive coloring.

Smoke houses are classed among the high fire-risks in a packing plant and should be built of fireproof materials and isolated from the adjoining buildings as much as possible. The entrance to the smoke house alley should be through a brick vestibule protected by double fire-doors. The alley or corridor into which the smoke houses open should have outside light and ventilation and the windows should be of fireproof material. All walls should be built of brick, laid in good cement mortar, with the joints filled solidly with mortar.

No wall should be less than 12 inches in thickness in order to keep the smoke and heat on that side of the wall where it properly belongs. An 8-inch wall is often built around one-story houses, but the slight saving made in the cost is not enough to offset the difficulties resulting from smoke and heat escaping through this thin enclosing wall.

The temperature of the smoke house must be maintained at 110° Fahr. during the smoking time and it is, therefore, necessary, in cold climates, to provide an air space between the roof and the ceiling, as a protection

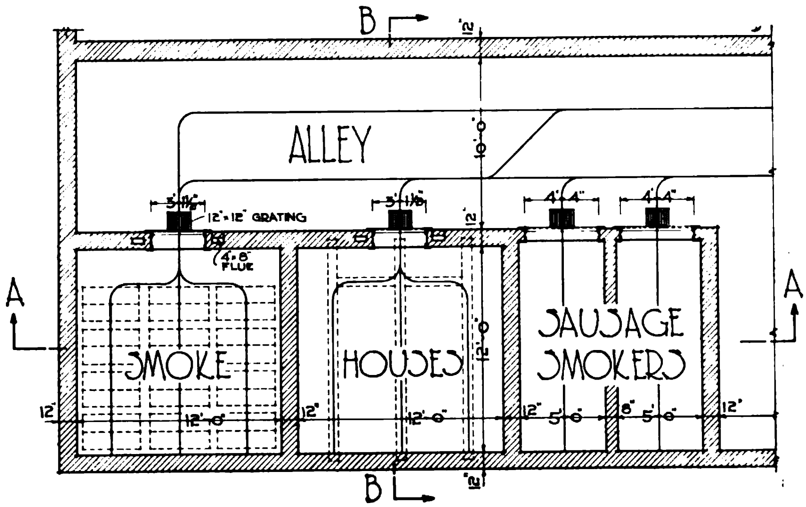


FIG. 55—PLAN OF SMOKE HOUSE.

against the cold coming through the roof. When the roof construction is of wood, the smoke flues should always be supported on the fireproof ceiling below, otherwise the woodwork will be exposed to the heat and sparks from the fire pit.

In smoke houses more than three stories in height it is necessary to install heating coils to maintain the required temperature in the upper stories.

An improved method of firing smoke houses has lately been introduced by the Airoblast Corporation of New York.

This method is patented and has been successfully tried out in Packing House practice. It consists of a gas burner in the form of a perforated pipe, which is laid on the firing pit floor. By a proper admixture of gas and air heat is produced and easily regulated. A metal hood is placed over

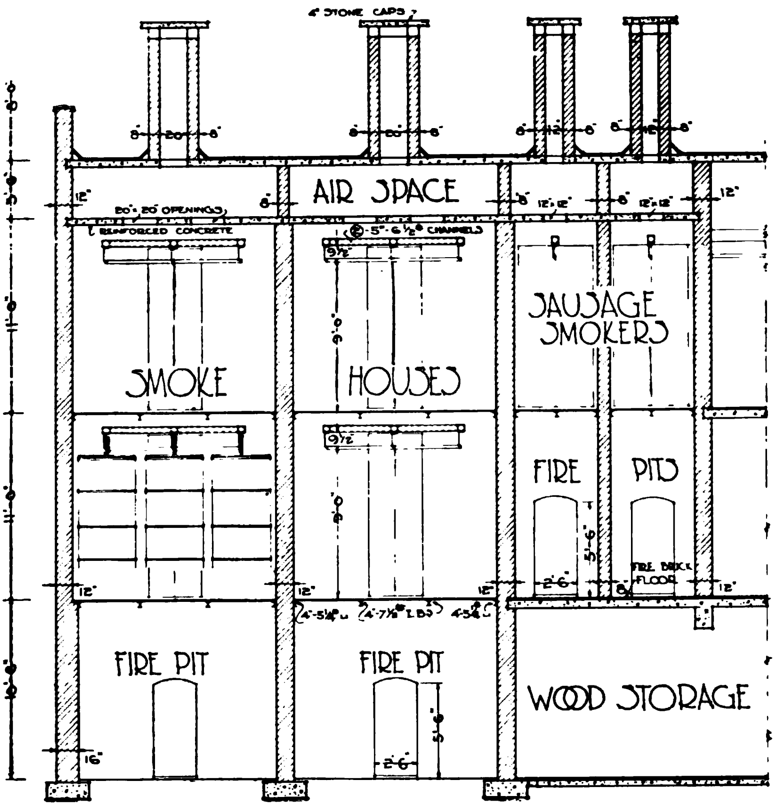


FIG. 56—SECTION A A OF SMOKE HOUSE.

the burner so as to deflect the flame downward and ignite the sawdust on the floor. Air is supplied by a small electric blower placed outside of the firing pit and the piping and control valves for gas and air are conveniently located near the thermometer in the door.

This method of firing has an advantage over the wood

fire in the ready control of heat and smoke and the ease with which the fires can be started and put out. The manufacturers claim that less time is required to properly smoke the meats and that the coloring is better and the shrinkage less.

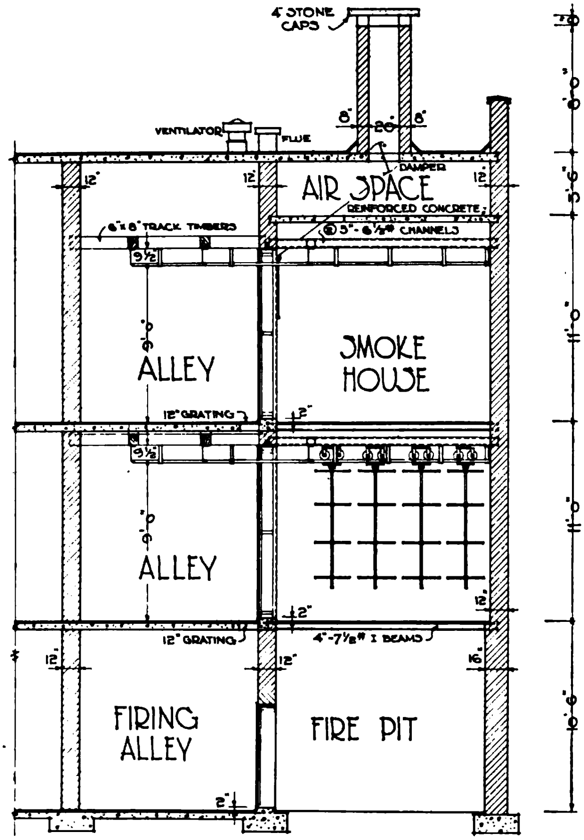


FIG. 57—SECTION B B OF SMOKE HOUSE.

Example of Smoke House Construction

In Figures 55, 56 and 57 is illustrated the construction of a two-story smoke house with firing pit in the cellar. The entrance is from a fireproof corridor ten feet wide built with concrete floors and roof.

The smoking capacity of this size house is 5400 pounds of meat in each story, when three-station trolleys are used. This capacity could be increased to 7200 pounds by placing the rail nine feet above the floor and using the four-station trolley.

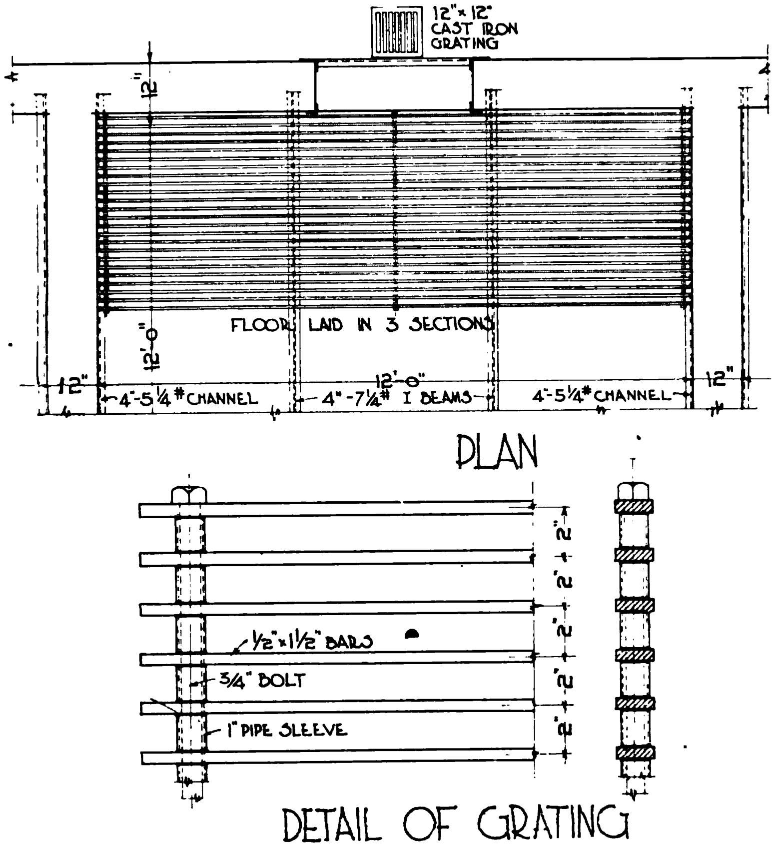


FIG. 58—DETAIL OF SMOKE HOUSE FLOOR.

The ceiling and roof over the smoke house are of concrete and the smoke flues of brick. The draft is regulated by a sheet-iron damper, which is counterbalanced and operated by a chain placed near the door opening on the top floor.

Steel beams support the iron grating used as a floor in the smoke house (see Fig. 58). The grating is removable and laid in three sections which can be taken out and cleaned.

Another and cheaper type of floor is illustrated by Figure 59.

This is made of $\frac{1}{4}$-inch wire-netting with 4 x 4-inch mesh and bound on the edges with $\frac{5}{8}$-inch steel rods. In cheap work the wire floor is made in one section (without the edges being bound) and built into the walls with intermediate I-beam supports at one or two points.

The construction of smoke house doors is illustrated in detail in Figure 60 and the fire pit doors in Figure 61.

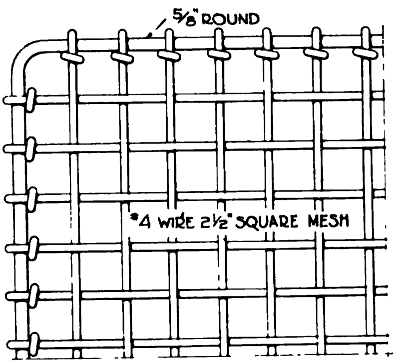


FIG. 59—DETAIL OF WIRE FLOOR IN SMOKE HOUSES.

The sill for the door should be placed two inches above the floor, with an angle-iron curb on the outside for the door to close against. A small iron grating is placed in the ceiling of the corridor, directly over the door openings to the smoke house, so that the smoke, which escapes when the doors are opened, can pass up to the next floor and out through a ventilator in the roof.

The ventilating flues, shown in the brick wall near the door, can be built at a small cost and will assist in ventilating the corridor.

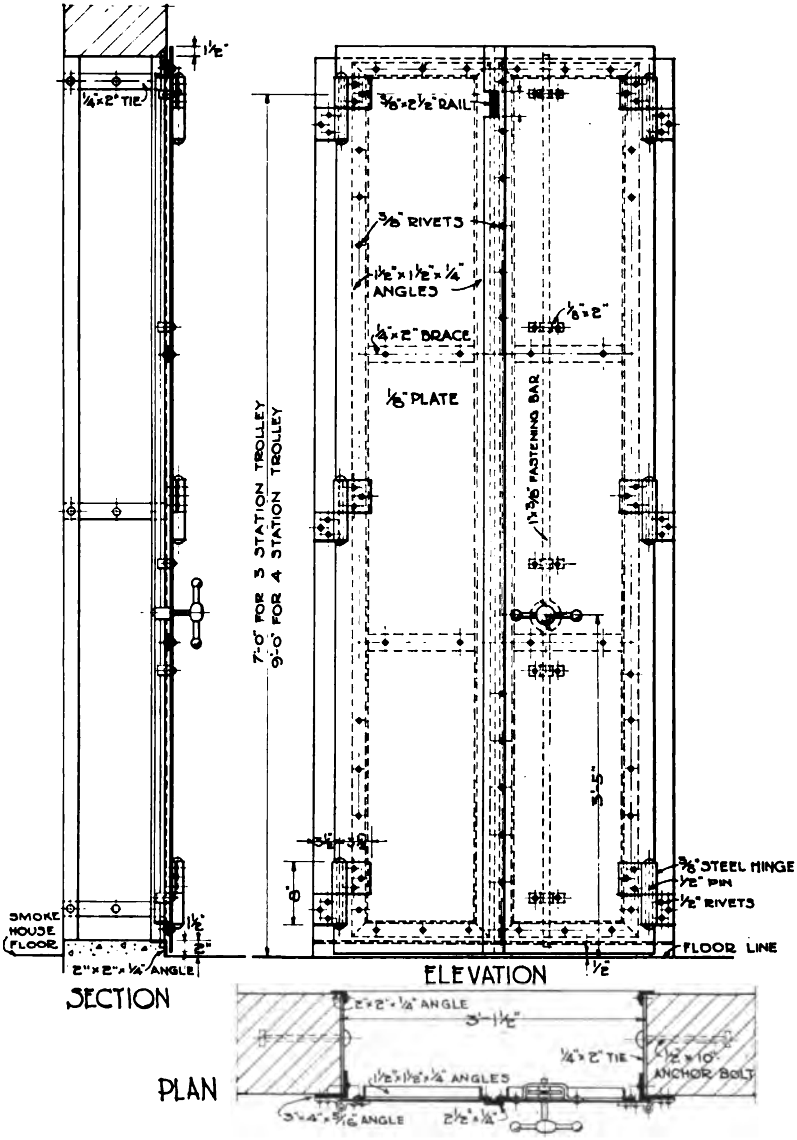


FIG. 60—DETAIL OF DOORS FOR SMOKE HOUSE.

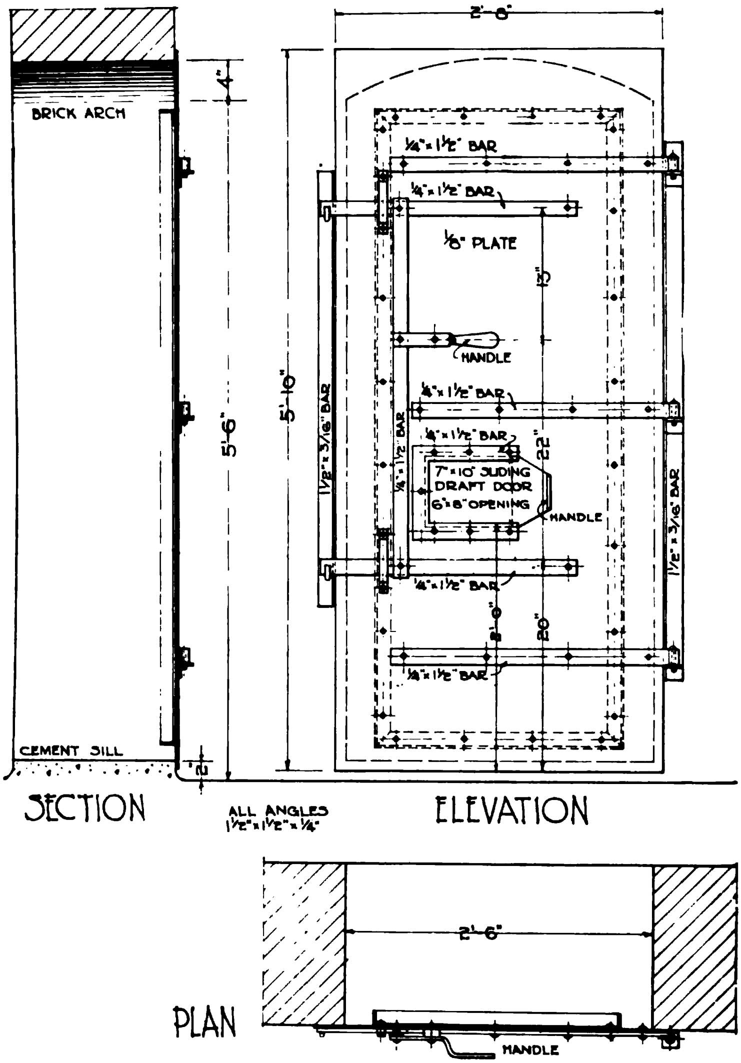


FIG. 61—DETAIL OF DOORS FOR FIRE PIT.

Figure 62 shows how the hangers for the smoke house are fastened. Two 6-inch channel irons, placed ¾ inch apart, are built into the walls and the hangers are put up with ⅝-inch bolts, placed between the two channels. In cheap construction, the hangers are fastened to 6x8-inch timbers, but this construction is not recommended, as the timber will sooner or later catch on fire.

The floor in the firing pit can be put down with well tamped clay, where the ground is dry and free from surface water. In wet soil, it is necessary to lay a watertight con-

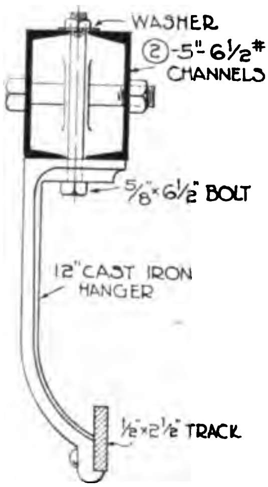


FIG. 62—DETAIL OF SUPPORT FOR TRACK HANGERS IN SMOKE HOUSE.

crete floor, which should be covered with hard-burned brick, laid in cement mortar.

In Figure 63 is illustrated a type of smoke house which is often used in wholesale markets and in buildings where the space on the first floor is too valuable to use for smoke houses. The fire pit is placed in the cellar and the smoke house is omitted in the first story.

The smoke from the firing pit is conducted to the floor of the second story smoke house through flues built in the wall and extended across the first story ceiling with two

outlets into the smoke house. The flues should be built with terra cotta lining and the openings regulated by dampers which will insure an even distribution of the smoke through the outlets.

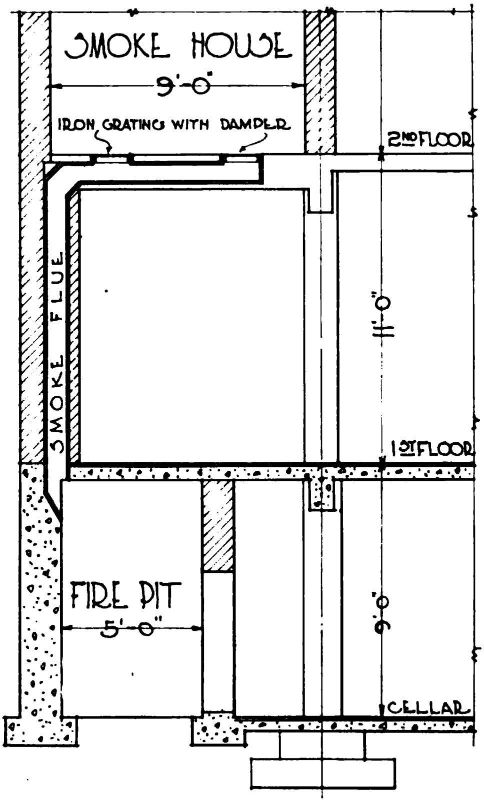


FIG. 63—FIRE PIT IN CELLAR AND SMOKE HOUSE ON SECOND FLOOR.

Smoked meat trolleys of a type frequently used are illustrated in Figures 64 and 65. The large size trolley will hold 450 pounds of meat and the smaller, about 300 pounds. This equipment can be purchased from any of the large packing house supply dealers or can be made locally in any well equipped machine shop.

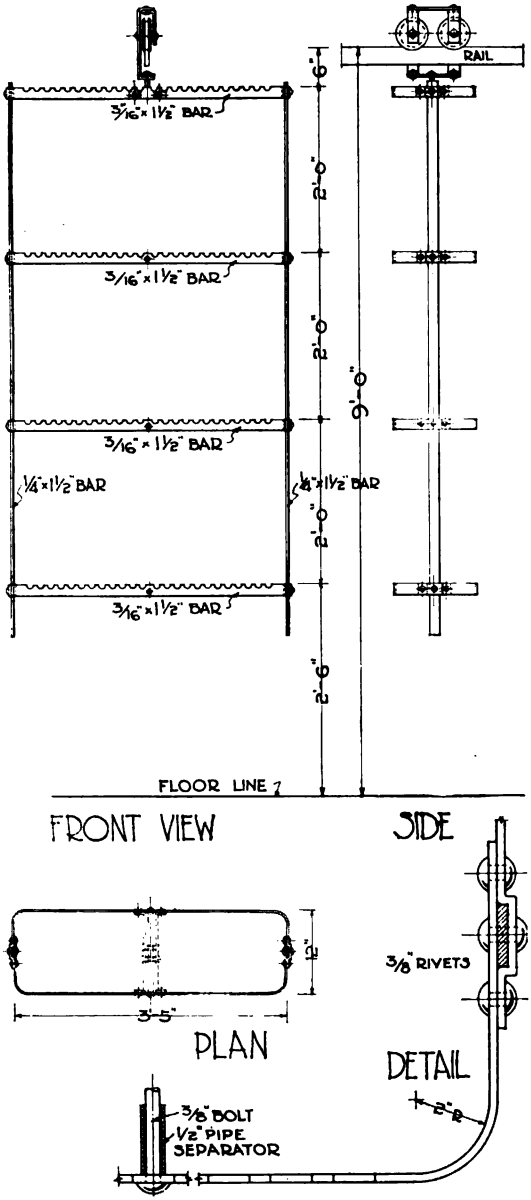


FIG. 64—DETAILS OF SMOKE HOUSE TROLLEY.

Sausage Smoke Houses

Sausage smokers are constructed on the same principle as previously described for ham and bacon smoking. The walls should be of brick and the floors and roof of

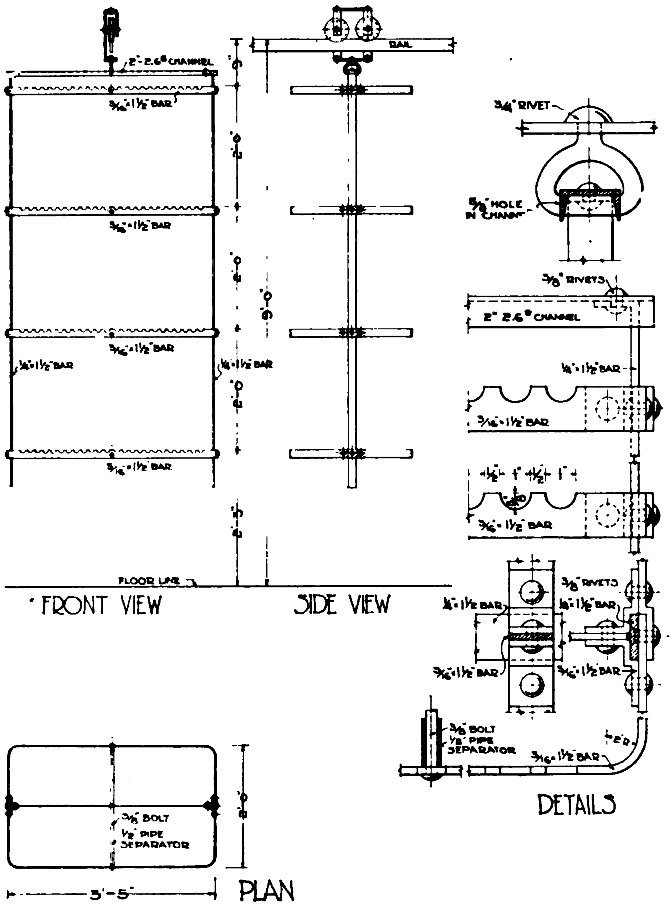


FIG. 65—DETAILS OF SMOKE HOUSE TROLLEY.

fireproof material. The width of the house is generally made fifty-four inches and the length eight feet or twelve feet, so as to accommodate the standard size sausage tree, which is forty-six inches wide and forty-six inches long.

The height of smoke houses will depend upon whether the sausage is to be smoked with a great deal of heat or with cold smoke. The single story house with firing pit directly below is generally used for the smoking of domestic sausage. For summer sausage it is necessary to have

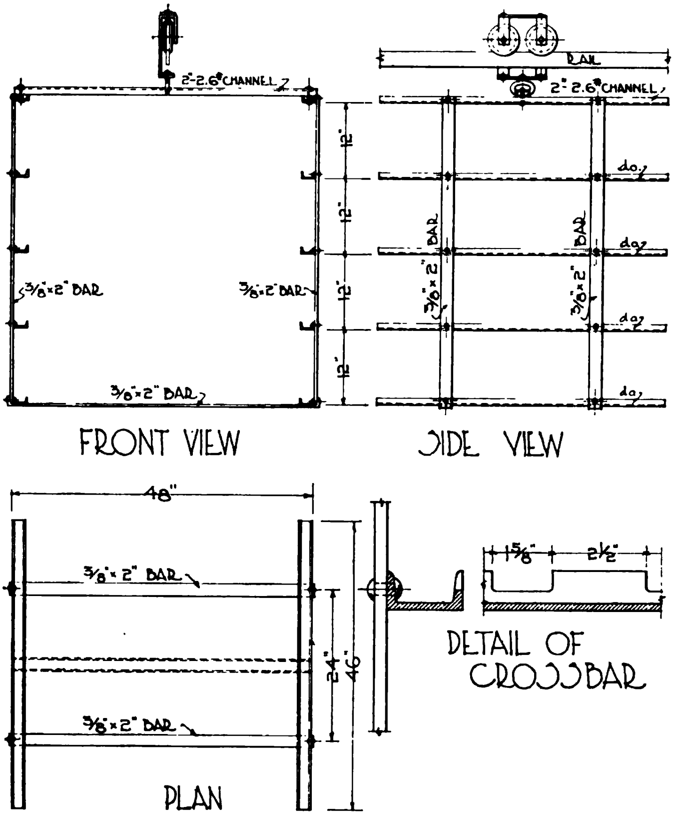


FIG. 66—DETAIL OF SAUSAGE RACK.

large houses, several stories in height, in which the sausage is kept in cool smoke under carefully regulated temperatures. The location should be as convenient to the sausage kitchen and cook room as the arrangement will permit and the overhead rails should be extended from the smoke houses to the sausage tables and the cook rooms.

In Figure 66 is illustrated a type of sausage tree in general use. It is made to hold a sausage stick forty-four inches long and is rigid and economical in its construction.

CHAPTER X

STOCK PENS

Storage pens must be provided in all plants, so as to have facilities on the premises for the storage and handling of live stock, after it is brought to the plant. Where there is ample room, the pens are constructed as a stock yard, with open or covered inclosures, and the yard is divided into sections, by alleys and drives. An inclined runway is built from the yard to the killing-floor and the stock driven up as needed.

Platforms should be constructed along the railroad track, and chutes for unloading should be built in front of each car door. Stock cars are generally built forty feet long; therefore, the chutes should be about forty-two feet apart and wide enough to allow for the smaller cars of less recent construction.

Facilities for unloading from wagons should also be provided, as well as stock scales and a scale house.

Stock yards should, preferably, be roofed over, so as to protect the stock during bad weather. This is particularly necessary for sheep and hogs. The modern yards are now built of reinforced concrete and paved with brick or concrete.

The Government requires that all hog pens be paved and properly drained and that all yards be provided with facilities for watering the stock.

In Figure 67 is illustrated a section through a covered stock yard built for the storage of cattle, sheep and hogs. The pens are of various sizes and are arranged so that all alleys connect with the runway to the killing floor. The roof over the alleys is raised above the main roof, and

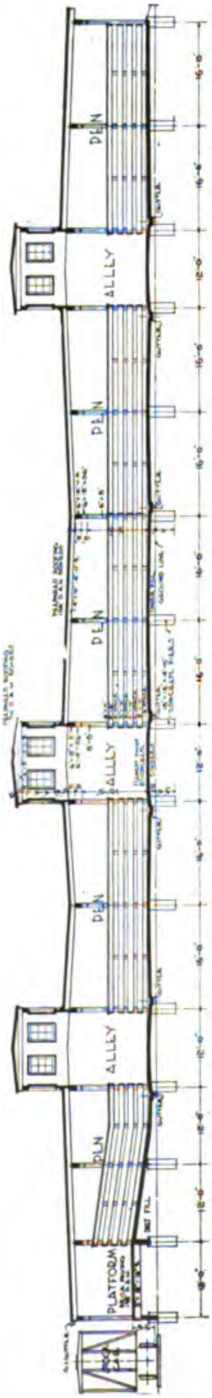


FIG. 67

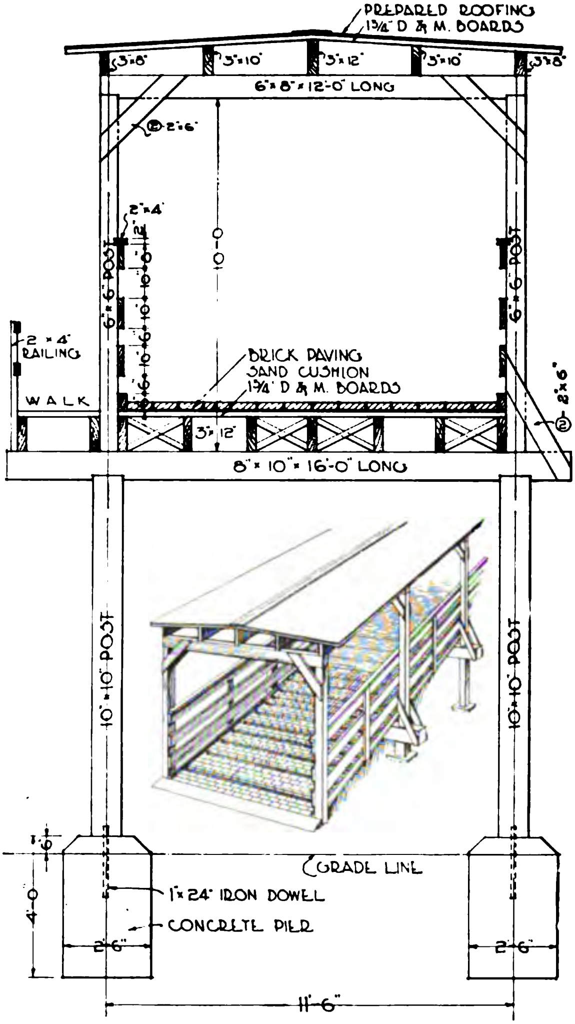


FIG. 68

FIG. 67—SECTION THROUGH STOCK YARDS.

FIG. 68—SECTION THROUGH STOCK RUN WITH DETAILS.

means for light and ventilation is provided by continuous monitors.

In Figure 68 is illustrated, in detail, the construction of a runway to the killing floor. The incline of the run should be three inches per lineal foot, if the space will permit, and should never be more than three and one-half inches, except for very short runs. The brick floor, laid with three courses of flat bricks, and one course laid on edge, will give a secure foothold for the live stock.

Where the ground space is limited, the stock pens must be built in decks, one above the other, from the ground to the killing floor level. This structure is generally placed adjoining or close to the slaughter house and should, therefore, be of sanitary construction and built of such materials as will not become a fire-hazard to the adjoining buildings. The floors must be waterproof and all parts of the building must be thoroughly ventilated and protected from the weather.

Reinforced concrete pens have been built with only a slight increase in cost over mill construction and when we consider that they are fireproof and can easily be kept in a sanitary condition, the additional cost must be looked upon as a good investment.

Storage Capacity of Pens

The pen room required for holding live stock in yards can be figured at 1000 square feet per carload of cattle and 500 square feet for hogs and sheep. Double-deck hog cars require twice this amount of space. This estimate includes alleys and drives.

Cost

A stock yard built at Sioux Falls, S. D., of a construction similar to that shown in Figure 67, including 6-inch concrete floors, and complete sewer and water installation, cost $41 per 100 square feet.

Concrete hog pens, 100x78 feet, four stories high, erected in Mason City, Iowa, cost six cents per cubic foot, complete with fencing, water and sewers.

CHAPTER XI

LUMBER IN PACKING HOUSE CONSTRUCTION

The use of lumber in packing houses has been greatly reduced by the introduction of reinforced concrete construction. There are, however, many instances in which lumber will be used, even in fireproof buildings.

The ease with which track-hangers can be bolted to overhead timbers makes wood indispensable in cooler buildings and on killing floors, and as support for machinery and equipment it has no equal.

The higher cost of fireproof buildings will influence many owners to use wood in the construction of their plants. Another factor, which may have considerable weight, is the increased use of automatic sprinklers, which greatly reduces the fire-risk and thereby overcomes one of the strongest objections which an owner has to wood construction.

For the reasons above stated, it may be of general interest to know what the conditions are which make lumber so unsatisfactory for general use in packing house construction.

When wood is exposed alternately to wet and dry conditions it decays very rapidly, on account of the growth of the lumber destroying fungi, which are forever present under humid conditions. Humidity and lack of ventilation will increase the growth of fungus, although the species which cause dry-rot will thrive, even with a scant water supply, and lie dormant for a long time under unfavorable conditions for growth.

Rot in wood is popularly supposed to be a chemical action similar to the rusting of iron. A closer study of the subject has proven that fungus is the *cause* of rot instead of a *result* of it. The result of the extensive research work done by the Bureau of Forestry at Washington, D. C., has given us a better understanding of the action of wood under various atmospheric conditions. We learn that several species of wood-destroying fungi will thrive in high temperatures while others are destroyed when the temperature is low. The result of this, in buildings, can be seen in dry-rot and damp-rot.

In packing plants it is the damp-rot fungi which are the more harmful and their effects can be observed wherever there is moisture and lack of ventilation. The rapid rotting out of posts immediately below the floor-line, and instances where the ends of girders and joists have decayed in the course of a few years, are only of too frequent occurrence.

These conditions are particularly noticeable around slaughter houses, refineries and tank houses, where steam and water keep the wood saturated to a much larger extent than in other parts of the plant. Certain acids, always present in the air in these buildings, also seem to favor the growth of fungi. Frequently, the wood close to the outlet of a hot water pipe, or immediately above a cooking-vat, will rot out long before the surrounding wood shows any signs of decay. This can be explained by the fact that the air in these places is so saturated with moisture that the wood becomes infected by an excessive growth of fungus.

In cellars where there is lack of ventilation, there is a noticeable decay of all wood. The author knows of a building where the pine planks in a cellar ceiling rotted out after five years. In reconstructing the cellar, new window openings were placed in both sidewalls and kept open, for ventilation, most of the time. After three years of service there was no noticeable indication of rot in any part of the ceiling.

In his book on "Dry-Rot in Factory Timbers," Mr. F. J. Hoxie recommends the heating of buildings as a means of arresting the growth of fungi. Heating and drying, with the consequent change in the humidity of the air, will stop the growth of certain fungi, which are destroyed when the temperature is maintained at 115° Fahr. for an hour or more. In practical application, the heating in a packing house could be done by putting steam on in the heating coils over Saturday and Sunday, during the summer months when the outside temperature is high.

Painting the woodwork after it is erected is of value, when the wood is thoroughly dry and sound before the paint is applied. Only oil or waterproof paints should be used and these should be applied in two or more heavy coats. Cold-water paints are useless, under these conditions, as they have no resistance to moisture.

Lumber Suitable in Packing Houses

Since the process of manufacture in packing houses will remain detrimental to the life of wood, it becomes necessary to select those varieties of timber which offer the most resistance to the attacks of fungi. We specify the best of materials for steel and concrete construction and pay the market price without further comment, but with lumber we are inclined to substitute the cheaper grades and pay double for it in the end, by having to replace it after a comparatively short time.

This policy may be all right where the first cost is the only factor to be considered, but should not be followed where good and permanent construction is desired.

A great deal of inferior lumber is used in packing plants on account of ignorance as to the requirements. Irresponsible contractors may take advantage of the owner's inexperience with the best grades of lumber, and if they should happen to be found out, will generally give the excuse that they were unable to get the grade specified at the mill without having to wait a long time for it. Incomplete specifications are also the cause of much inferior lum-

ber being used, and it requires a good knowledge of the different grading rules to properly describe the exact quality which is desired. When the lumber arrives on the job it should be carefully inspected by someone who understands what has been specified and who is competent to pass upon the quality of the lumber which has been delivered. Any piece which is not up to specifications should be marked and rejected.

It is a short-sighted policy to buy anything but the very best grades of long leaf yellow pine or Oregon fir. White pine, which was formerly used in packing plants, and with excellent results, is now too expensive for anything but thin flooring and insulation work. From the experience we have had in the past, we know that only the highly resinous and close grained woods will give satisfaction, and even their usefulness, in a packing plant, is comparatively limited.

Yellow pine is a very hard, close grained wood, is strong and heavily impregnated with rosin and wood oil. These preservatives act as a filler to keep moisture out of the pores of the wood and preserve it from decay.

The Oregon fir, or pine, is a wood which closely resembles the yellow pine and is about nine-tenths as strong as the best long leaf pine. It is lighter in weight and less resinous and is therefore not so well suited for packing house work as the better grades of pine.

This quality of the timber is rated according to whether it contains heartwood or sapwood. The heartwood is more resistant to decay than the softer and less resinous sapwood and should therefore be specified.

Varieties of Southern Pine

Southern pine is generally known as "Long Leaf" and "Short Leaf" yellow pine. The long leaf is a heavy, resinous and fine-grained wood which possesses great structural strength and durability. It grows in the states of Georgia, Alabama, Mississippi, Florida, Louisiana and Texas.

The "Short Leaf" yellow pine is lighter in weight than

the Long Leaf, somewhat less resinous, coarse-grained, and with a large percentage of sapwood. It grows principally in North Carolina and Arkansas, but is also found in the states mentioned above, when soil conditions favor its growth.

When the trees of the two varieties are cut up into lumber, it is often very difficult to distinguish between the better grades of Short Leaf and the inferior grades of Long Leaf, and, unless the quality of lumber is clearly specified, the mills will generally send a mixed shipment of both varieties.

The scarcity of the best grades of long leaf lumber makes it expensive and difficult to buy. European buyers, who consider quality above price, are large purchasers of Long Leaf yellow pine and there are lumber mills in the South which never quote or ship to domestic markets. Their output is cut and graded entirely for foreign demand.

Why Resinous Wood Should Be Used

The present system of grading and selection under which yellow pine is being sold does not give sufficient guaranty that the lumber will be of the quality called for by the specifications of the purchaser.

The classification of timber is a question of strength and durability, and the percentage of rosin is generally considered as the most reliable index of durability for the Southern pine. There is generally a wide variation in the rosin content between the top-end and the butt-end of a tree, and the timber cut from one tree will, therefore, be of various grades in quality. It may all show the required percentage of heartwood, but the resistance to decay will differ in proportion to the rosin contents when the lumber is used in buildings where there is much dampness.

Contrary to common belief, heartwood without rosin is not immune from rapid decay. The author quotes the following interesting observation by Mr. Hoxie: "The limiting amount of rosin just sufficient to stop the growth of fungus is in the neighborhood of three per cent. The

limiting power of rosin is undoubtedly not absolute, but varies with the variety of fungus and time of exposure. It is, therefore, safe to assume that a mill-beam should have four to five per cent of rosin throughout to successfully withstand fungus by its own power of resistance, under ordinary conditions of dampness."

In packing houses where the dampness is excessive and far above the ordinary conditions found in factory buildings, the lumber would need to be of an even higher quality.

Specifications for Structural Timber

Where the purchaser is willing to pay the price, he can undoubtedly obtain the best grade of yellow pine timber if he makes his requirements known to the lumber dealers.

The specifications of the American Society for Testing Materials are in part as follows: "All timber, except as noted, shall be of long leaf yellow pine, sawed to standard size, square-edged and straight; shall be close-grained and free from defects such as injurious ring-shakes and cross-grain, unsound or loose knots, knots in groups, decay or other defects which will impair its strength."

To the above specification should be added, that all square timber must show 95 per cent heart on all four sides; all rectangular timber must show 95 per cent heart on the girth, throughout the length of the piece; provided, however, that if the maximum amount of sap is shown on either narrow face of the stringer, the depth of the sap shall nowhere exceed one-half inch; knots shall not exceed four inches in their largest diameter.

The heartwood must show a sharp contrast in color between the springwood and the summerwood and show not less than eight growth-rings per inch, measured over the third, fourth and fifth inches on a radial linc from pith to eircumference. The percentage of rosin shall be not less than five per cent in any part of the timber, and the weight of all timbers shall not be less than forty-six pounds per cubic foot.

Wood Preservatives—Chemical Treatment

The treatment of wood with preservatives, to prevent its rapid destruction, has been in use for some time. Heretofore, it has principally been confined to railroad ties, paving blocks and telegraph poles, but more attention is now being paid to its use for factory timbers.

The scarcity and high cost of the better grades of pine timber necessitates the use of the less durable, ordinary quality of pine, and we know that this class of timber must be replaced in a packing house, after six to ten years of service, if not before, unless some means of increasing its durability be employed.

The life of railroad ties is more than doubled by being treated with creosote. With factory timber there is as yet not sufficient experience to prove how great an increase in its durability will result by treatment with preservatives. The fungus destroying power of various antiseptics has been experimented with under conditions of actual service which promise to give very satisfactory results. The coal-tar compound used for treating railroad ties and poles is not suited for interior work on account of the disagreeable odor and increased fire hazard. Liquid oils or varnishes do not prevent fungus from destroying wood if the conditions of humidity are favorable and their use is strongly objected to by the fire underwriters.

At the convention of the American Wood Preservation Society, Mr. F. J. Hoxie read a paper on "Treated Timber for Factory Construction" and recommended therein the use of the "Mercury" or "Kyanizing" process, which is extensively used in some countries in Europe with excellent results. The method of treatment employed, according to Mr. Hoxie, is to soak the material in a one per cent solution of corrosive sublimate dissolved in water, using one pound of the sublimate to 12 gallons of water.

This solution should be mixed in a wooden or concrete vat, built on the ground, and the lumber allowed to soak therein for a period of from three to seven days, depending upon the size of the timber.

The solution attacks iron or other metals; therefore it is not practicable to use it in metal tanks. This process is recommended on account of fifty years of successful experience, and the ease of applying it as well as its economy.

The cost of treating has averaged about three dollars per 1000 board-measure feet of lumber.

Care must be used in handling the corrosive sublimate, as it is poisonous if taken internally.

CHAPTER XII

SANITATION, PLUMBING AND DRAINAGE

The installation of the plumbing fixtures, drainage and sewer systems in packing plants must be subject to the requirements of the local Health Department.

In Government inspected plants the requirements of the Bureau of Animal Industry must also be complied with. Their requirements are, "that in compartments where food products are prepared, handled or stored, all plumbing should be so installed that the same standard of sanitation will be obtained as that required in dwellings erected to conform with modern methods of plumbing installation."

Toilet Rooms

The best arrangement of toilet facilities in moderate sized plants is to provide a central toilet station for the men. This should be located where it is easily accessible from all parts of the plant and convenient to the dressing room. The accommodations should include one water closet for each 20 employees, large trough urinals and wash-basins. Where three or more closets are necessary, the range closet will be found the most satisfactory, as it is easily kept clean and in repair. Each seat should be partitioned off, either with slate or heavy galvanized iron, placed 12 inches above the floor. The closets should have continuous flushing service and be of sufficient depth to allow for an ample body of water in the trough at all times. The floor of the toilet room should be of impervious material and properly drained. The walls and partitions should be plastered for at least five feet above the floor line and preferably painted in a light color. Good ventilation and natural light is essential and the windows should be kept open at all times of the year.

With a central toilet station, it will be expedient, in large plants, to provide urinal stalls and wash-basins convenient to departments which employ a large number of men. These accommodations must be located in rooms with outside light and ventilation and where the sanitary conditions are faultless. Toilet rooms for women should have one closet for each 15 employees, and individual, automatic features should be installed. All toilet fixtures must be separately trapped by an approved water-seal trap, placed as close to the fixture as possible. The trap should be vented at its highest point and the vent-pipes carried above the roof. All soil pipes should be of extra heavy cast-iron, with joints caulked with lead. Vent and waste pipes can be of galvanized wrought iron with screwed joints. The fixtures should be of the heaviest pattern, either of earthenware or enameled cast-iron and should be selected for their sanitary and durable qualities.

The Government requires that when the toilet opens directly into a room where edible products are prepared or stored, the entrance must be through a vestibule in which there is outside light and ventilation. The door must be fitted with a self-closing attachment which will keep it closed.

Floor Drains

Packing house floors are drained by gutters or cast-iron floor drains. Gutters are used where there is much water on the floor and where a great number of floor drains would not be desirable. They should be made continuous across the room and stop within 12 or 16 feet of the walls, in order to drain all water away from the wall-lines.

Gutters 48 feet in length or over should have two drain outlets four inches in diameter. For short gutters, one 4-inch outlet will suffice. The outlets should be located near the columns, so as to shorten the connection with the waste-stack.

All outlets must be trapped with a cast-iron water-sealed trap and connected to a waste-stack which is vented through the roof. The best type of trap for a floor drain

is the "P" trap shown in Figure 69. It should be made with a hand hole and brass screw for cleaning out.

The Bureau of Animal Industry recommends that each outlet be vented from the crown of the trap. This would require a separate vent-stack alongside the waste-stack, where the drains on more than one floor are connected into one stack. The Bureau has not enforced this rule, except where the traps are subject to siphonic action. It is sufficient to extend the waste-pipe in full size from the top floor up through the roof.

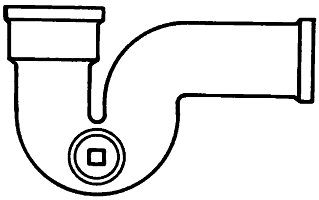


FIG. 69—"P" TRAP.

Floor drains are generally used in beef and hog coolers where the floor is covered with saw-dust or mill-shavings, which absorb the drippings from the meat. These floors are not washed down as frequently as manufacturing floors, therefore drains can be used to advantage and installed at less expense than continuous gutters.

Gutters and drains should not be placed farther apart than 32 feet in packing house floors. This will generally mean that the gutters will be built at every other row of posts.

The slope of the floor should not be less than one-fourth of an inch to the foot. Slaughter house floors are often given a pitch of five-eighths of an inch.

Defective drainage is frequently caused by the fact that the foundations of the walls will settle proportionally more than the inside column foundations. That part of the floor which is supported by the wall, will naturally settle with the wall, causing imperfect drainage to the gutters. The author, therefore, recommends that the high-point of

the floor along the side-walls, be raised one inch more than will be needed for the inside floor.

The details of floor gutters are illustrated and described in Chapter XX.

Cast-iron drains with Bell trap, are frequently used instead of gutters. They should be of heavy cast-iron, with removable top and strainer. Bell traps are not recommended for use except when the drain-pipe is also trapped by a "P" trap. Unless this is done, the fixtures would be without a trap, if the strainer and bell was removed, and as these are frequently broken in cleaning out the cess-pool, there should be an additional protection to satisfy the sanitary requirements.

All floor drains which empty into the grease catch basin should be placed so that the outlet of the drains is submerged in water. This is done to prevent the odors from the catch basin from contaminating the drainage system.

Catch basins should be located outside the buildings, when the arrangement will permit. In no case should they be placed inside of a room in which edible products are handled.

Dressing Rooms

Plants under Government inspection must provide adequate dressing room for the employees, in which wearing apparel can be hung. The room must be thoroughly ventilated and lighted by windows or sky-lights.

The floor should be waterproof and drained, so that it can be cleaned and washed down with a hose. All walls should be plastered or painted with oil paint and heating coils should be installed so that the working clothes can be dried over night. The Government recommends that where lockers are provided for the clothing, these should be arranged in separate compartments; one for street clothes and the other for working clothes. All lockers should be well ventilated and preferably made of metal.

In connection with the dressing room, there should be installed a shower-bath for every fifteen employees. The showers will add greatly to the general cleanliness and com-

fort of the employees and can be installed at a slight expense.

A substantial, inexpensive shower can be made with No. 18 galvanized iron partitions, fastened to 2x4-inch uprights and painted with two coats of enameled paint. The floor is covered with the same material and has a drain outlet in the centre.

Catch Basins

In packing houses, catch basins are used as storage reservoirs for the waste water which contains particles of fat, either in solid or suspended state. This water comes from the manufacturing and killing floors, curing vats and tanks, and from any other source where there is a possibility of saving any fat. This is skimmed off the surface of the water and sent to the inedible rendering tanks. The water from the catch basin is then run off into the sewer, the flow of the water is continuous and the same amount which enters the basin at one end is discharged into the sewer at the opposite end.

The principle of construction is to provide room for the storage of a sufficient body of water to allow all suspended particles of fat to rise to the surface before the water reaches the outlet to the sewer.

Since the specific gravity of fat is so much less than water, it will quickly rise to the surface unless it is prevented from doing so by currents and whirlpools, created by faulty construction or by the insufficient size of the basin.

A common fault in many catch basins lies in the many partitions put in with alternating over and underflows. These divide the space into many small compartments in which there is always too much of a current for effective results. These currents flow alternately in opposite directions. With an underflow, the tendency is to give a downward motion to the water and this, in passing under the partition, will create an upward current in the next compartment. This agitation interferes with the operation of the laws of gravitation and prevents a complete separation of the lighter and heavier substances.

Another common fault is the tendency to build the basin too narrow and at the same time, too shallow. It then acts merely as an open drain, with little or no possibility of retaining and skimming off the fat.

An effective catch basin should be of sufficient size to handle the waste water without too rapid a flow to the sewer outlet. If the approximate amount of water to be diverted to the basin is known, the size can be calculated on the basis of 10 gallons of water per cubic foot of basin. Thus, if the waste-water in a plant equals 200,000 gallons every 24 hours, the basin should be $\frac{200,000}{10x24} = 833$ cubic feet capacity. With a 3-foot depth of water and a basin four feet wide, the length would need to be 70 feet.

In the construction of such a basin it will be found more economical to make it in two lengths, open at one end, and with a skimming platform in the centre, as shown in the cellar plan of the packing plants, illustrated in previous chapters.

The body of the water in the basin should not be too deep, from three to four feet is sufficient. Deep basins not only increase the distance which the fat must travel to reach the surface but they also unnecessarily increase the cost of construction. When the cellar drainage discharges into the catch basin, the water in the basin must stand at the same level as that of the lowest drain entering the basin. In Figure 70 is shown the construction of a catch basin for a small packing plant. The outside walls are 12 inches thick at the top and 18 inches at the bottom and are reinforced with ½-inch steel rods. The skimming platform is in the middle between the two basins and is reached from the cellar of the adjoining tank house.

When the basin is skimmed off, the grease is dumped into the open trough in the platform-floor through which it runs to the blow tank. When this is filled, the contents are blown, by steam, up to the rendering tanks.

The partitions are placed so that there is an overflow over the first one which permits all solid matter to be held

back in the first compartment and this is made the entire length, on one side of the basin. The second and third partitions are each set eight inches above the floor, thus creating an underflow which holds back all floating fat. The fourth and last partition is an overflow and is set at the same level as the lowest drain entering the basin. All drains

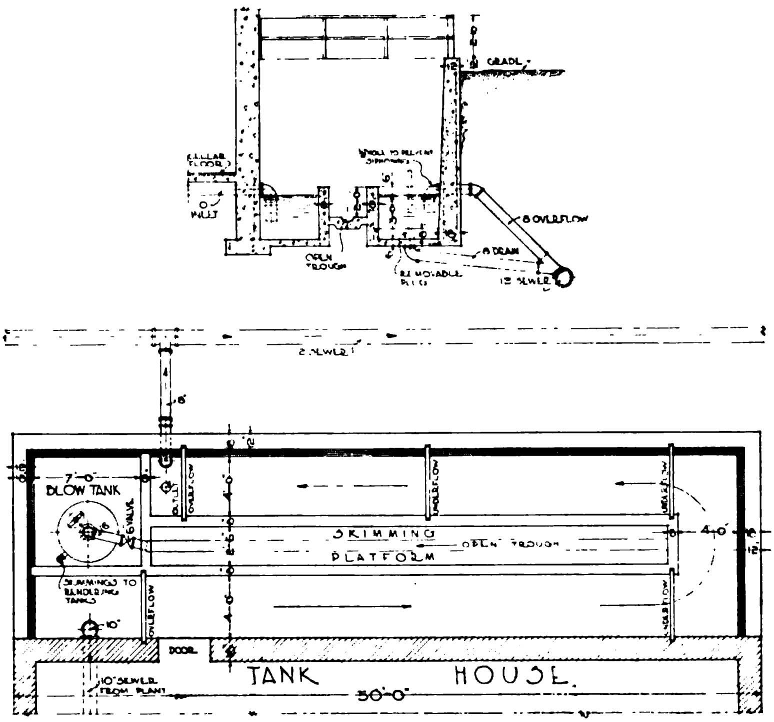


FIG. 70—PLAN AND SECTION OF CATCH BASIN.

should be provided with an elbow at the entrance to the basin, so that the water will be discharged downward, below the surface. This will provide a waterseal for the drainpipes and prevent the odors of the basin from contaminating the drainage system. Similarly, the outlet pipe should be turned down one foot below the water level, so as not to carry off any of the floating grease. An outlet should be

provided to drain the basin where the main sewer is of a sufficient depth. Since the basin must be cleaned regularly, this sewer connection will avoid the necessity of pumping out the water.

CHAPTER XIII

COMMERCIAL COLD STORAGE BUILDINGS

Introduction

The introduction of mechanical refrigeration has made possible the present development of the cold storage industry as a public utility in the preservation of food products. It has opened up a new field for an industry, which is destined to become of more and more importance as long as man must eat.

The preservation of food by means of cold storage is of comparatively recent origin, when we consider that man has congregated in large cities as far back as history records, and in so doing must have collected and stored foods in quantities above his immediate and daily requirements.

The benefit to be derived by having cold storage facilities for the preservation of foods must have been brought home to mankind about the time that the countries to the North became inhabited, and man lived the year round in a climate which provided him with cold storage temperature for at least a part of the year.

We must assume that he early wished to prolong this period of food preservation beyond the expiration of its natural days, for the original man-made cold storage house is of ancient origin. It was devised by making a dugout in the North side of a hill and filling the cavity with ice from a nearby lake or river. Meats and fish could thus be preserved for home consumption by being placed in direct contact with the refrigerating medium.

We know that this type of cold storage proved a success by the fact that it is still in use in the localities where it originated.

The improvements which have since been made in the construction of buildings refrigerated by natural ice have been many and varied, and always more or less satisfactory, generally the latter.

When the refrigerating machine was developed to be of commercial value there was an immediate and rapid growth of cold storage warehouses, both for public and private use.

This development began shortly before 1890 and today we find buildings of this kind fifteen stories high, where every floor is being utilized for commercial cold storage, with temperatures ranging from 15° Fahr. below zero to 30° and 40° Fahr. above.

The ease with which these various temperatures can be maintained in properly constructed and insulated buildings, has materially reduced the cost of refrigerated space and caused an increased demand for cold storage room.

Advantages of Cold Storage

The producer and commission merchant have been quick to realize the advantages of placing all kinds of perishable products in cold storage. Without this means of preservation, many commodities which are raised in season, must be placed on the market and disposed of at the prevailing low prices and at a time when the market is generally overstocked.

The return to the producer is correspondingly less, and often an anticipated and well deserved profit will prove to be a loss. This naturally discourages growers from a continued production of many staple necessities.

With cold storage space available at reasonable rates, the producer and commission merchant alike are in position to relieve the market of an over-supply of products. The consumer can be supplied according to the demand, and a market is created the year around for goods which heretofore were available only in the immediate seasons in which they were produced.

Cold storage has made it possible to carry the surplus production of fruits, vegetables and produce during the

entire period of natural scarcity and has enabled the producer to raise these products in larger quantities than heretofore was possible and dispose of same at profitable prices, thus adding to the yearly quantity of food-production and general prosperity.

It may be interesting to know the extent to which cold storage temperatures are used in the preservation of commercial products. The following list of articles, stored in one public cold storage warehouse in Boston, was filed, for record, during the public hearings before the United States Senate Committee on Manufactures:

Anchovies
Apples
Apricots
Apple Waste
Bananas
Berries
Beans
Bulbs
Brussels Sprouts
Butter
Beer
Buckwheat Flour
Crabs
Caviar
Citron
Cheese
Cereals
Condensed Milk
Confectionery
Cider
Chestnuts
Cherries
Candied Fruits
Cranberries
Currants
Carrots
Canned Goods
Cream
Cabbages
Cauliflower
Clams
Cucumbers
Dates
Dried Fish
Dried Meats
Eggs
Egg Plant
Evaporated Peaches
Flour
Fruit Juices
Furs
Ferns
Fish for Bait
Figs
Frozen Fish
Game
Gutta Percha
Grapes
Grape Fruit
Hams
Holly
Hops
Horse Radish
Honey
Herbs
Jellies
Lettuce
Leeks
Leather
Lobsters
Lard
Laurel Leaves
Lemons
Maple Syrup
Meat, Fresh
Maple Sugar
Melons
Macaroni
Mushrooms
Nuts
Oysters
Oranges
Onions
Oleomargerine
Oils
Olive Oil
Olives
Poultry
Preserves
Peanuts
Pickled Fish
Pineapples
Pickled Nuts
Pears
Prunes
Potatoes
Parsnips
Pickles
Parsley
Peas
Provisions
Plants
Peaches
Peppers
Radishes
Raisins
Rice
Rhubarb
Spinach
Squash
Skins
Sauerkraut
String Beans
Sponges
Salad Dressing
Sausage Casings
Smilax Leaves
Sweet Breads
Smoked Meats
Scallops
Smoked Fish
Syrups
Shallots
Turnips
Wines
Woolens
Yarn

The success of the cold storage industry has been due to the fact that it has proven equally beneficial to the producer and consumer and eliminated an unnecessary waste of valuable food products. It can truthfully be said that the cold storage industry serves as a balance wheel between supply and demand.

Cold Storage Subsidies

It may be of general interest to know that the Canadian Government, in 1907, passed the Cold Storage Act, which provides for the payment of subsidies to public cold storage warehouses, under certain stipulated conditions, to the extent of 30% of the cost of such plants.

The report of the Dairy and Cold Storage Commissioner for the year 1914 shows that 30 plants have been erected in Canada, under contract for subsidies, since this act was passed and that four new plants were then under construction. The Commissioner's report contains the following interesting comment upon this subject: "The Cold Storage Act has encouraged the erection of small cold stores at country points. In this way, storage facilities are provided as near as possible to the point of production, and the goods are placed in cold storage with the least possible loss of time or chance of deterioration. These local warehouses tend to prevent the accumulation of large quantities of perishable produce in the main centres of distribution, and the writer believes that there is no surer or more satisfactory way of providing against a manipulation of prices by an unfair use of the cold storage industry in holding perishable foods of seasonal production.

"The main advantage, however, in having local cold storage warehouses at points of production is that such a plan enables the producer or dealer to place his perishable goods in safe keeping with the least possible delay. They can be transported to consuming centres at a more favorable season of the year, or in any case in large enough quantities to permit of carload shipments and the use of refrigerator cars. The movement of produce, from the producer of small lots to dealers or customers at distant

points, must be carried out in many cases in less-than-car-load-lots and, therefore, without the protection afforded by the iced car.

"The prejudice which exists in some quarters against cold stored foods has its root very largely in the fact that these foods are often out of condition before they reach the warehouse. The local cold storage helps to prevent such conditions from arising.

"Since the passing of the Act in 1907, thirty public cold storage warehouses have been erected and received the subsidy, with a total refrigerated space of nearly 5,000,000 cubic feet, practically doubling the refrigerated space for public use which was then available."

Location and Shipping Facilities

Commercial cold storage plants are classed as Public Utilities and should be located where they are most convenient to the trade. This includes the country producer and shipper, as well as the wholesale and commission merchants in the city.

A suitable location must provide ample railroad facilities for the handling of products shipped in carload lots and should be within a short haul of the wholesale distributing centres for cold storage products.

A site of this kind in our big cities can now be secured only by paying high prices for the land and may lead to the selection of a less advantageous location. The most successful cold storage warehouses are those which have private switch tracks where a great number of railroad cars can be received and unloaded at one time. (How this is arranged for in some of the plants now in operation is illustrated in Chapter XIV.)

In the Merchants Cold Storage and Warehouse Co.'s plant in Chicago (Chapter XIV) the railroad tracks were placed inside of the building with platforms alongside of each track. An additional track was provided for the south end of the building so that nine cars can be handled at one time on this property.

A better arrangement would have been to run double

switch-tracks along the rear of the building, but the location of the connecting railroads was such that this plan had to be abandoned.

It is safe to state that no large cold storage building was ever built with sufficient trackage for railroad cars. With this in mind the arrangement of a new plant should provide all track facilities which conveniently can be placed on the property. Two sidings are often placed alongside the building and the cars on the outside track are then unloaded by passing through the cars nearest to the building. This saves time in switching the cars in and out and reduces the labor cost of handling big shipments.

Large consignments of cold storage commodities are shipped in from outside points and stored in warehouses until such time as they will be re-shipped to other markets. If these goods are handled by a house which is without railroad facilities, it would be necessary to haul the shipment by team from the nearest railroad yard to the cold storage house and back again, and the cost of handling must be taken out of the storage fee.

The financial success of a public cold storage warehouse is so dependent upon adequate railroad facilities that too much attention can scarcely be paid to this feature. As an illustration of this, it can be stated that in Chicago there are only three of the fifteen large public cold storage buildings which are without railroad connection adjoining their property.

Facilities for the handling of local goods by teaming must be arranged for.

Many cities permit the loading of wagons across the sidewalk and this saves valuable space within the building. Where this cannot be done, a team loading-court with shipping platform must be provided for on the property, so as not to interfere with traffic on the street.

A convenient and practical arrangement for a loading-court is to omit that part of the first floor adjacent to the street and build the second floor of the building out over the court. This will require a space 30 feet deep, if the

horse and wagon are to be kept inside of the sidewalk line.

The operation of the power and refrigerating plant in a cold storage building requires a large amount of coal daily and the plant should be arranged so that the coal can be unloaded in front of the boiler room.

The water supply for the ammonia condensers must be considered. This is a large expense item in the operating cost unless a cheap supply of water is available. Most plants install their own deep water well, even at the expense of going down 1,500 to 2,000 feet for water. The cost of such installation and the pumping of the water up to the condensers should be carefully considered for comparison with the rates given on city water.

The temperature of well water in the summertime compared with that of other water supplies, should have consideration before the water question is decided upon, as the amount required for the condensers depends largely upon the temperature of the water when it flows over the pipes. Some advantage may be gained from the installation of suitable water cooling towers and this factor should be considered.

The advantages of a favorable location for a new cold storage enterprise, which must enter into competition with those already established, need not be further commented upon.

CONSTRUCTION FEATURES

Fire-Proof Construction

Modern cold storage warehouses have been built of fire-proof construction, with a few exceptions. The permanence of this class of construction, with low charges for depreciation, reduced cost of maintenance, better sanitary conditions and the practical elimination of vermin, are strong arguments in its favor.

The low insurance rates which can be secured on the commodities stored in a fireproof warehouse, will attract business to this class of buildings.

High land values in large cities require buildings with great storage capacity, in order to earn interest on the capital invested, and this will necessitate the erection of high buildings of fireproof construction.

The difference in cost between slow-burning and fireproof construction is not sufficient to offset the many advantages which a strictly fireproof warehouse will have over any other class of construction.

These facts should be considered and the cost of insurance, maintenance, and depreciation on the various types of buildings should be figured and compared with the first cost of construction, before a final decision is made.

Mill Construction

Where the cost of construction must be kept down or in localities where lumber is plentiful and cheap and large size timbers are available for mill constructed buildings, a considerable saving can be made by using this type of construction.

The term "mill construction" means a slow burning building with incombustible walls and roof covering and wherein the posts are not less than 10x10 inches and girders and joists have a sectional area of not less than 72 square inches. The floors must be at least $3\frac{1}{2}$ inches thick, and the roof boards $2\frac{5}{8}$ inches. All structural iron or steel must be covered with two inches of fireproof material and inside partition built of 2-inch lumber or of some satisfactory fireproof material.

In order to get the lowest insurance rates on mill construction buildings, they must be constructed strictly according to the recommendations of the National Board of Fire Underwriters. Their principal recommendations are that buildings of large areas must be divided into units by fire walls and communication between buildings must be through fireproof vestibules, with double fire doors on all openings. Stairs and elevators must be located in such vestibules, and standpipes with hose connections provided for each floor.

When automatic sprinklers are installed in a carefully

designed mill building, the insurance rates will generally be lower than in a fireproof building, which is not sprinkled. On account of the low temperatures maintained in cold storage rooms, it will be necessary to install the sprinklers by what is termed the "Dry System" in which the water is drained from the pipes and held back by a dry valve at a point outside the building.

This type of installation is more expensive but equally effective to the ordinary "wet system" where the water is carried in the sprinkler pipes under pressure at all times. Sprinkler installations in cold storage rooms are not in high favor among the warehouse men. The pipes interfere with the refrigerating coils, particularly in freezer rooms and where the sprinklers must be placed below the coils there is considerable loss of storage space. Sprinkler heads are easily damaged and if a careless workman accidently opens one of the heads when piling goods, this may result in serious loss on account of the room being flooded and the goods damaged by water. For the reasons above stated, it will require a very substantial reduction in the insurance rate to make it profitable to install sprinklers in a cold storage building.

Ordinary Construction

In this chapter the subject of the construction of cold storage warehouses has been confined, so far, to fireproof and slow-burning types of buildings. Those who do not regard good construction as the one essential of modern buildings, and wish to build at the least expense, will resort to the ordinary wood construction with small sized posts and girders and with floor joists, spaced close together and covered with one or two thicknesses of flooring. One of the greatest defects in this type of building, and one which should be closely guarded against, is to support the floor construction on stud partitions instead of on girders and posts. The heavy loads placed on warehouse floors and the vibrations from frequent shifting of commodities held in storage will in time have the tendency to spring the studding and cause the floors to sag. Partitions of this kind can

not be moved if changes in the interior arrangement of the building are desired. In case of fire, they offer little resistance to the flames and when partly burned, they will cause the floors to collapse.

With heavy timber construction, the supports will often stand up under fire until this can be extinguished and much damage avoided to that part of the building not directly affected by the flames. For this same reason, unprotected steel columns or girders should not be substituted for heavy timber, as they will not resist fire nearly as well as large, solid timbers.

The Use of Reinforced Concrete for Cold Storage Buildings

In fireproof construction, reinforced concrete seems to be best adapted to cold storage buildings, where the height does not exceed ten stories. Steel constructed buildings of the same height will be more expensive without adding to the life or efficiency of the plant. The difference in cost between structural steel and reinforced concrete buildings is from 10 to 20 per cent, according to the best authorities. And in cold storage construction, where it is necessary to provide double columns and beams along all outside walls the difference in cost may exceed even these figures.

The available storage space in the lower stories of a tall building will depend somewhat upon the size of the columns, and since concrete columns must be made much larger than steel columns, to carry the same load, we arrive at the maximum height of ten stories for cold storage buildings, when concrete construction is used.. Columns 30 inches in diameter, made of reinforced concrete, mixed in the proportion of one part cement, one part sand and two parts of crushed stone, were used in the basement of a ten-story cold storage warehouse designed by the author. The spacing of the columns was 16x18 feet and the live load on all floors was figured at 200 pounds per square foot. This size column was not objectionable from a storage standpoint but appeared to be about the maximum size which should be used in a carefully designed building of this character.

The saving made by using concrete columns instead of structural steel was a considerable amount and more than sufficient to offset the reduction in storage space in the lower stories.

Floors built of reinforced concrete should be designed to meet the special requirements and conditions of a cold storage warehouse. These requirements are so exacting from the standpoint of insulation, piping, overhead tracking, drainage, etc., that the most careful consideration must be given to all details.

In Figure 71 is illustrated a type of floor construction which is often adopted by inexperienced designers of cold storage buildings. Concrete girders are placed between the columns, and smaller floor beams built crosswise between

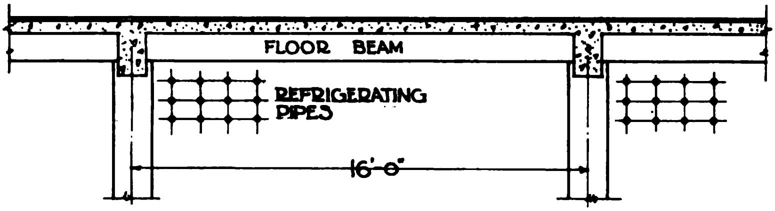


FIG. 71—SECTION OF FLOOR WITH BEAM AND GIRDER CONSTRUCTION.

the girders, in order to reduce the thickness of the floor slab. This arrangement of structural members reduces the amount of reinforcing steel required, and is, therefore, advocated by many engineers who design and sell steel for concrete buildings. This type of floor construction is not adapted to cold storage rooms on account of the lost space between the refrigerating pipes and the ceiling above. This loss will amount to 12 inches on each story, when the girders are 16 feet apart, which is the usual distance in common practice for this class of building. The story heights must, therefore, be increased accordingly, in order to have the required height for storage below the piping. In a ten story structure this would mean ten feet added to the height of the building, without any increase in the storage capacity. Another objection to this type of construction

will be found in the girders and beams on the underside of the ceiling. These interfere with the free circulation of air in the rooms and cause moisture to condense on the ceiling.

The same type of construction is frequently used where structural steel is employed instead of reinforced concrete and is, therefore, subject to the same criticism.

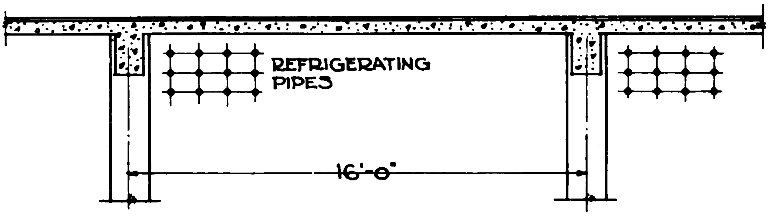


FIG. 72—SECTION OF FLOOR WITH GUTTER CONSTRUCTION.

In Figure 72 is illustrated a type of floor construction in which the crossbeams are omitted and the reinforced concrete slab supported directly on the girders. With this arrangement the refrigerating pipes run parallel to the girders and are placed close to the ceiling, so as not to reduce the headroom for storage.

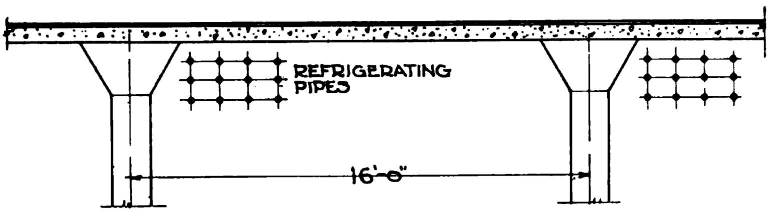


FIG. 73—SECTION OF FLOOR WITH CANTILEVER FLAT SLAB CONSTRUCTION.

This construction is specially recommended when the floors must be drained by continuous gutters, which is often required in packing house coolers. The gutters should then be placed close to the girders and the reinforced floor slab depressed to the required depth of the gutter.

In Figure 73 is illustrated a flat slab type of floor, where both girders and beams are omitted. This floor is

very well adapted to cold storage construction and has been used in many buildings recently erected. The flat ceiling-surface provides an unobstructed surface for the circulation of air and the refrigerating pipes can be placed in any direction desired without interfering with the storage of goods.

The only objection which the author has found with the flat slab construction is in the draining of the floor. It

FIG. 74—FORMS FOR CANTILEVER FLAT SLAB FLOOR.
Merchants Cold Storage & Warehouse Co., Chicago, Ill.

is impossible to design the reinforcement so as to take care of continuous floor gutters, except by placing wide and shallow beams directly under the gutters, and this is not a satisfactory solution of the problem. Where this feature does not enter into the construction, the flat slab is recommended as the most economical and practical floor for cold storage purposes.

In Figure 74 is illustrated the forms for the first floor of a cold storage building built with flat slab floors. Note

the double wall columns and the split columns in the centre of the building.

Walls

The construction of exterior walls for cold storage buildings has received a great deal of attention from architects and engineers in the past, and the result has given us a lot of information from which to draw conclusions regarding the best methods to follow.

The walls of present buildings have been built in various ways. We have solid brick walls, stone walls, reinforced concrete walls, tile walls, with and without plastered exteriors, and a combination of hollow tile and brick.

Walls are classified as self-supporting when the load is carried by the wall, and as curtain walls when the load is carried on steel or reinforced concrete beams and columns.

The selection of material to be used in the construction should be governed by the type of wall under consideration. In high buildings where all the weight is supported on the skeleton construction, it will be more economical to use the lightest material in order to reduce the size of the supporting frame work and the foundation.

For buildings up to five stories in height, a self-supporting wall of the thickness required by the City ordinance, will be the most economical to construct. When the height exceeds five stories, the skeleton construction should be adopted.

In modern cold storage construction, the walls act only as an enclosure around the building and the loads from the floor and roof are supported on an interior framework, placed adjacent to the wall. These should, therefore, be built of the material which will most effectively resist the transmission of heat and moisture. The insulating value of a wall is never taken into consideration when figuring the insulation, and the relative heat transmission of the different building materials can, therefore, be considered as a negligible factor. The ability of a wall to resist moisture is of far greater importance, since the wall acts principally as outside protection for the insulation and the efficiency of

this is always more or less affected by moisture. For this reason, the solid brick or concrete walls are not so well adapted for outside walls as hollow tile. The porosity of ordinary building brick is frequently so great that during heavy rainstorms the water has been known to penetrate a 12-inch wall and run down on the inside.

Hollow tile walls are undoubtedly best adapted to cold storage use, from an insulating standpoint. They resist moisture and have some value as insulating material on account of the hollow spaces where the air is confined. The structural parts of the tile will transmit heat through the wall, practically to the same extent as if solid material were used in the construction, and it is not recommended that less insulation be provided, than is used with brick or concrete walls.

The cost of unplastered tile walls will be about the same as when common brick or concrete is used. Plastering will increase the cost about five cents per square foot of wall surface, and since it adds to the life of the wall and greatly improves the appearance, it should not be left off.

A combination of hollow tile and hard vitrified brick, as illustrated by Figure 75, is recommended for the construction of all types of cold storage walls. It can be used equally well for self-supporting as for skeleton walls.

The vitrified brick will resist moisture better than any other building material of the same cost, and when laid as a veneer against an inside backing of hollow tile, we have a combination of materials which will give excellent results. The wall should be laid in Portland cement mortar and the brick should be bonded to the tile with a continuous header course of brick every two feet. The thickness of the wall should not be less than 16 inches, four inches of brick and twelve inches of tile. This, however. must be governed by the requirements of the building regulations and the Insurance Underwriters.

Insulation and Its Influence on the Construction

The purpose of the insulation in a cold storage building is to prevent, as much as possible, the transmission of

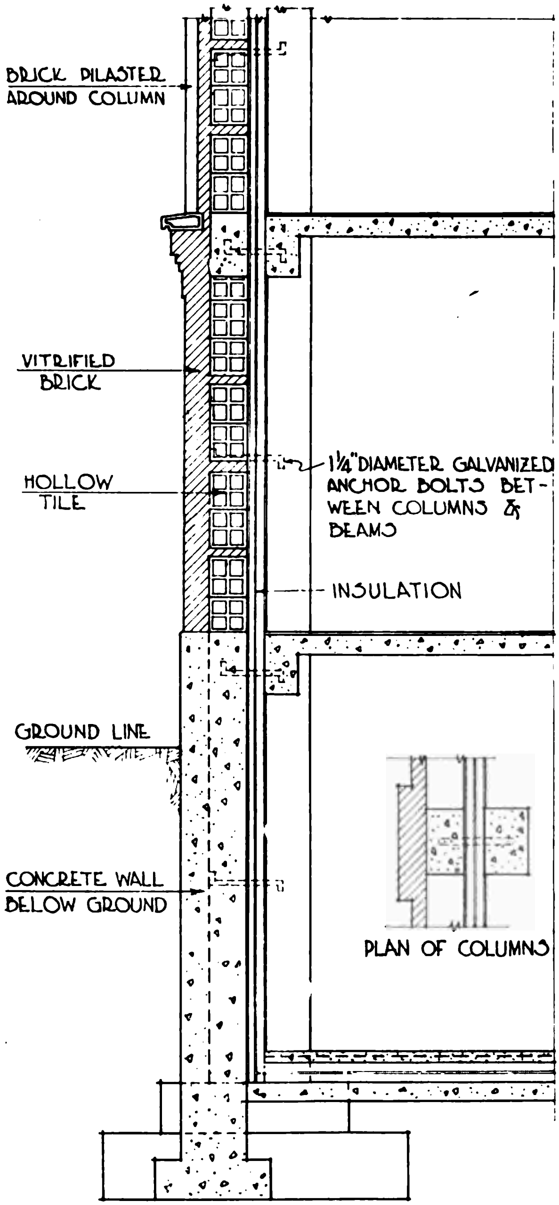


FIG. 75—SECTION THROUGH COLD STORAGE WALLS.

heat from the outside surroundings to the inside of the building. Therefore, the most efficient way of insulating would be to entirely separate the interior construction from the outside walls and fill the space between with insulating material. This is the method adopted in all modern warehouses.

The illustration shown in Figure 75 is typical of this kind of construction. Here the outside walls are built independently of the inside structure and the floors and roof are supported on columns and beams placed adjacent to the wall. The distance between the wall and column is determined by the thickness of the insulating material. The building is tied together with iron anchors placed in the walls and built into the columns and girders at all floor-levels.

The insulation is applied to the wall and continued up behind the columns and beams until it meets the roof insulation, which is laid on top of the roof structure. In this manner, the interior of the building is entirely enveloped by the insulation. The only contact between the walls and the interior structure is through the anchor-bolts and these are only a fractional percentage of the total wall surface and therefore practically negligible.

Another and cheaper method of construction is illustrated by Figure 76. Here the loads from the floors and roof panels adjoining the walls, are carried by girders which rest on the outside walls. In order to reduce the transmission of heat through the girders, these are insulated on the sides and ends where they come in contact with the brick wórk.

The tops and bottoms of the girders are, therefore, the only parts through which any heat transmission can take place. The floor slab is kept away from the wall and the insulation made continuous from cellar to roof, except where the girders intersect. At the end panels of the building, where the floor slab (in ordinary construction) would rest on the wall, it becomes necessary to place beams be-

tween the girders, to carry the end of the floor slab, in order to provide room for the wall insulation.

Where large buildings are divided into separate fire-risks, the fire-walls should be constructed in the same manner as the outside walls and insulated against the passing of cold from one section of the building to another. This applies also to the construction of walls around vestibules and elevator shafts.

Public cold storage buildings must be built to carry goods in temperatures ranging from 10° Fahr. below zero to 32° Fahr. and above. The space should, therefore, be

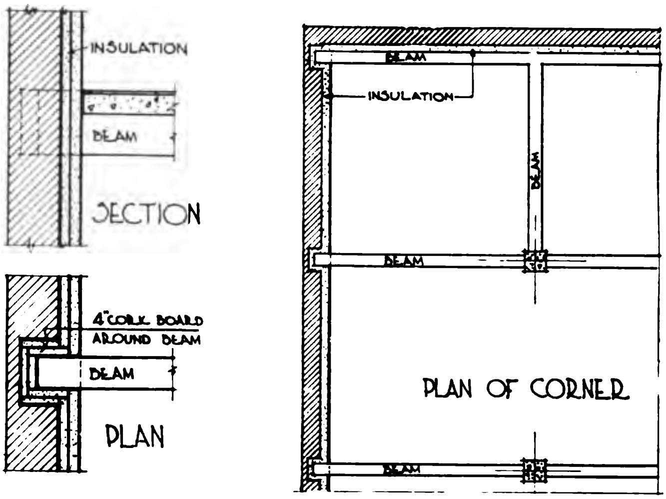


FIG. 76—INSULATION OF BEAMS IN OUTSIDE WALL.

divided into freezer and ordinary cold storage rooms, and the division between the two kinds of cold storage must be insulated.

The most economical and efficient arrangement of the space would be a vertical division of the building into sections and to maintain nearly the same temperature on all floors in any one section. This would require an insulated partition or division-wall between each section, but there would be no need of insulating any of the intermediate floors or ceilings between the cellar and the roof.

The cost of the insulation will be materially reduced where this arrangement is carried out as will be seen by the following comparison:

A three-story building 100x100 feet is divided into two-thirds cold storage and one-third freezer storage. If the top floor is used as a freezer, the floor must be insulated, which would mean 10,000 square feet of insulation. On the other hand, if the building is divided vertically into two-thirds cold storage and one-third freezer, this would only require an insulated partition 100 feet long and about 33 feet high, equal to 3,300 square feet of insulation. The saving would be 6,700 square feet. If cork board is used the approximate price would be 30 cents per square foot for 4-inch cork and the saving $2,010.00.

The dividing partition between the two kinds of storage should be built continuous from one end of the building to the other, and from the lowest floor to the top. In order to do this the columns and floor beams should be split as shown in Figure 77 and the insulation continued between the columns and up through the floor construction.

The vertical division of the space makes it unnecessary to insulate the columns as the cold traveling downwards through the columns will be of the same temperature as that in the rooms.

In tall buildings there is an advantage in insulating the ceiling every third or fourth story. This makes it possible to shut off the refrigeration on a series of floors in case the business does not require that the entire building be refrigerated.

Horizontal divisions of insulated space in a concrete building should always be made by placing the insulation on the ceiling and not on the floor above.

Cork insulation can be laid in the forms before the concrete is poured, at less expense than when it is placed on top of the concrete slab after this is completed. It avoids also the necessity of laying a wearing-floor over the insulation.

The insulating of floors which rest on the ground, is a

question over which there is a wide difference of opinion. The temperature of the soil, taken a few feet below the surface, remains practically constant at 55° Fahr. and must be considered as a fairly good conductor of heat. It would, therefore, seem advisable to insulate all ground floors with the same care as would be used under similar conditions above the ground.

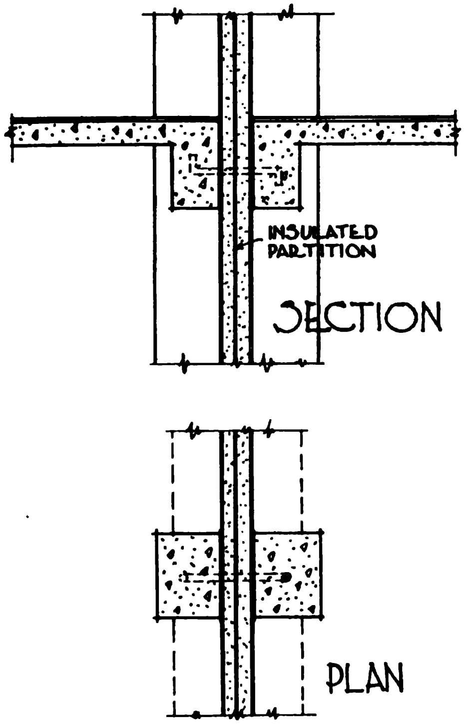


FIG. 77—INSULATION THROUGH FLOOR.

Freezer rooms should not be placed in the basement of any building. The problem of insulating the floor so as to prevent the frost from getting into the ground is one which is most difficult to overcome.

The author knows of a building in which the freezer floor was insulated with six inches of cork over six inches of concrete and under this was placed a bed of 12-inch dry

cinders. The underlying ground was supposed to be thoroughly drained by tile sewers, but, in spite of this, the ground froze solid for 18 inches below the cinders and caused considerable damage to the building. It should be mentioned that the columns were protected by five inches of cork board.

The roof must be insulated when the top-story is refrigerated and where the attic is omitted between the ceiling and the roof.

This method of construction is now generally adopted for well-designed buildings. It reduces the height of the outside walls and decreases the expense accordingly.

The roof insulation is laid directly on the roof-structure in a bed of liquid asphalt and the finished roofing put down over the insulation.

If an air-space is built over the top-story, the attic thus formed should be well ventilated on all sides, in order to remove the heat which comes through the roof.

The insulation over the attic floor can be laid with granulated cork or some other kind of loose filler and should be protected by a covering of boards.

The dense materials which are used in the construction of fireproof buildings make it necessary to insulate between floors in cases where the rooms above and below are carried at different temperatures. Unless this is done a great deal of annoyance will be experienced from moisture which condenses on the ceiling.

Concrete columns should be insulated to prevent sweating, in rooms where the temperature is higher than in the room above or below. This refers particularly to columns in shipping rooms and offices, where these are located within the cold storage building.

It is the author's experience that offices cannot be located successfully in a building which has cold storage rooms on the floor above or below the office. The great difference in temperature on the two sides of the insulation will make the office damp and humid in the summer and very difficult to heat in the winter. These conditions not

only affect the health of the employees but make it difficult to keep stationery and office supplies in proper condition.

In a cold storage building designed by the author, there were freezer rooms above the office and it was necessary to turn on steam in radiators every morning during the warm weather to overcome the dampness in the office. The concrete ceilings and columns were insulated with six inches of cork board and plastered.

Details of insulation designed for use in modern cold storage buildings, are illustrated and described in Chapter XV.

CHAPTER XIV

EXAMPLES OF RECENT COLD STORAGE CONSTRUCTION

Example No. 1

The following illustrations, Figures 78 to 82, inclusive, show the plant of the Merchants Cold Storage and Warehouse Co., in Chicago, Ill., which was erected in 1913.

The building occupies an area of 230x130 feet and is seven stories high with cellar. On account of the large area occupied, it was decided to divide this into three sections, separated by brick fire walls. This was done principally to avoid the increase in insurance rate which the companies impose upon buildings of this character when the area is in excess of 10,000 square feet. The division of the floor space also provided a convenient and practical arrangement of the plant from an operating standpoint, inasmuch as commercial demands require storage rooms with temperatures ranging from 10° Fahr. below zero to 32° Fahr. and above. Each section of the building was, therefore, designed for the storage of goods to be carried at certain temperatures. The north end was arranged for freezer storage, the centre section for eggs and apples and the south end for storage of fruits and vegetables.

Goods are received and shipped over three private switch tracks, of which two enter the building in the centre section and the third runs alongside the south end. This trackage provides storage room for nine cars at one time.

Local shipments are handled by wagon delivery from the front of the building, and the sidewalk on Halsted street was raised to the level of the first floor and used as a platform.

The elevators were placed adjoining the central shipping platforms with two elevators on each side of the railroad tracks.

All communications between the different sections are through fireproof vestibules, with the door-openings protected by double fire doors. The vestibules were made to include the elevators and stairways, allowing ample pas-

H. P. Henschien, Architect

FIG. 78—MERCHANTS COLD STORAGE & WAREHOUSE CO., CHICAGO, ILL.

sage room for the handling of trucks to and from the elevators.

The building is of fireproof construction, with brick walls carried on concrete skeleton framework. The floors are of the flat slab type of reinforced concrete and were designed for a load of 200 pounds per square foot of area.

The arrangement of all structural parts will be seen by referring to the floor plans and section. The outside

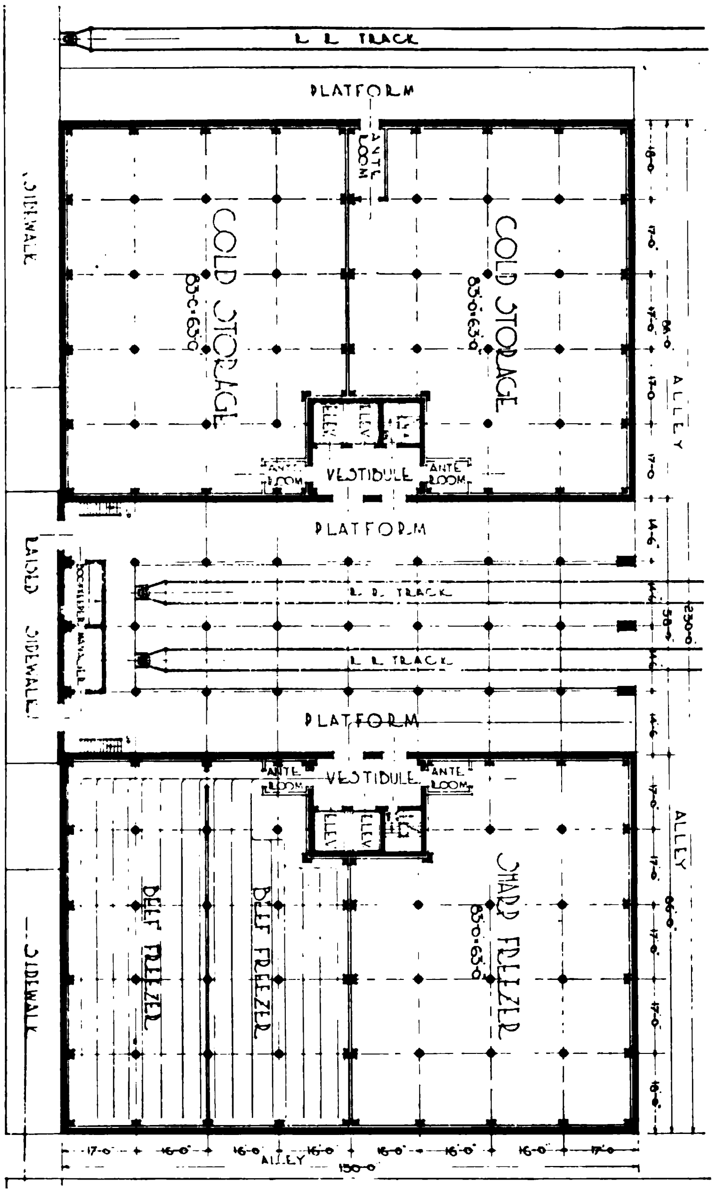


FIG. 79—FIRST STORY FLOOR PLAN—MERCHANTS COLD STORAGE & WAREHOUSE CO., CHICAGO, ILL.

walls support only their own weight and do not carry any of the loads from the floor and roof construction. The floor panels adjoining the walls are supported on concrete columns placed six inches away from the wall. This is done to provide room for the insulation which is built behind the columns and made continuous from the cellar to the roof. The interior of the building is, therefore, entirely surrounded by the insulation and there is no contact between the walls and the floor construction except the 1-inch anchor bolts, which tie the structural parts together.

Corkboard of the thickness shown in the section was used as insulating material and was put up with cement mortar in the cold storage rooms and with hot asphalt in the freezers. The insulation has given very satisfactory results during the two years in which the building has been in operation. It may be of general interest to know of one exception to this statement and one which was not foreseen at the time the building was designed. The owners experience some difficulty in keeping an even temperature along the east wall of the centre section during the winter. This difficulty is only present during heavy windstorms accompanied by a freezing temperature. The cold then penetrates into the rooms and makes it necessary to place lanterns along the wall to prevent the goods in storage from freezing.

Since there are only two small windows on each floor in this section (84 feet), it must be assumed that this difficulty is caused by the increased atmospheric pressure on the outside of the wall which enables the cold to penetrate even the insulation.

The top story of the building is not refrigerated and it was therefore necessary to insulate the entire ceiling of the sixth story. This could not prevent the cold from passing up through the columns supporting the roof and these were, therefore, made of cast-iron and the hollow space inside of the column was filled with granulated cork, for a distance of four feet above the floor line.

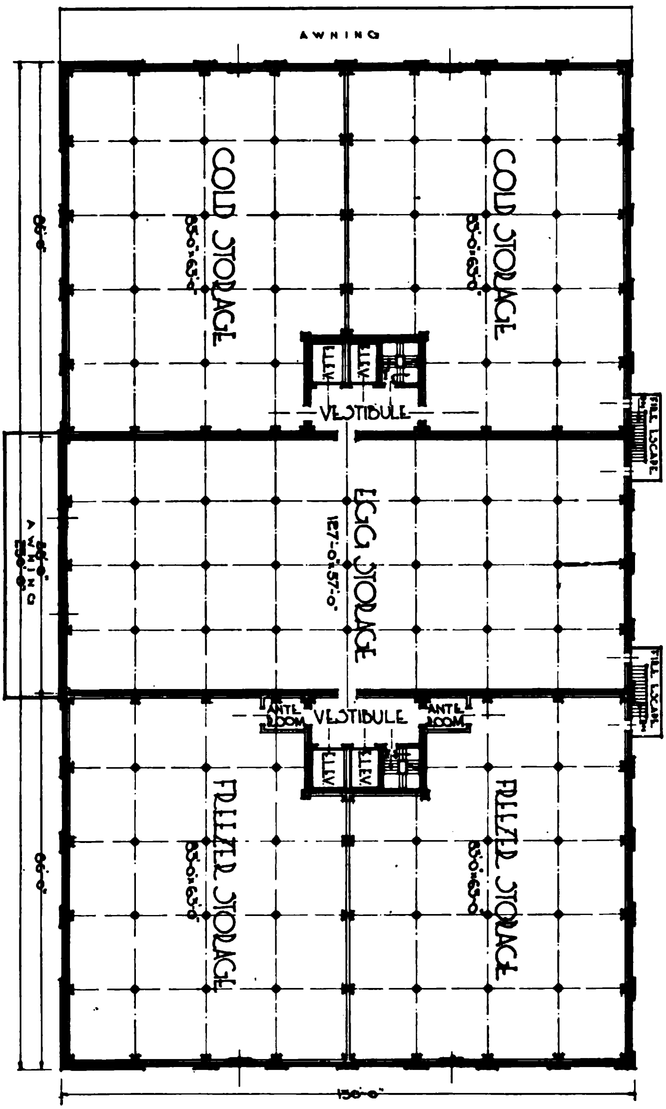


FIG. 80—TYPICAL FLOOR PLAN—MERCHANTS COLD STORAGE & WAREHOUSE CO.

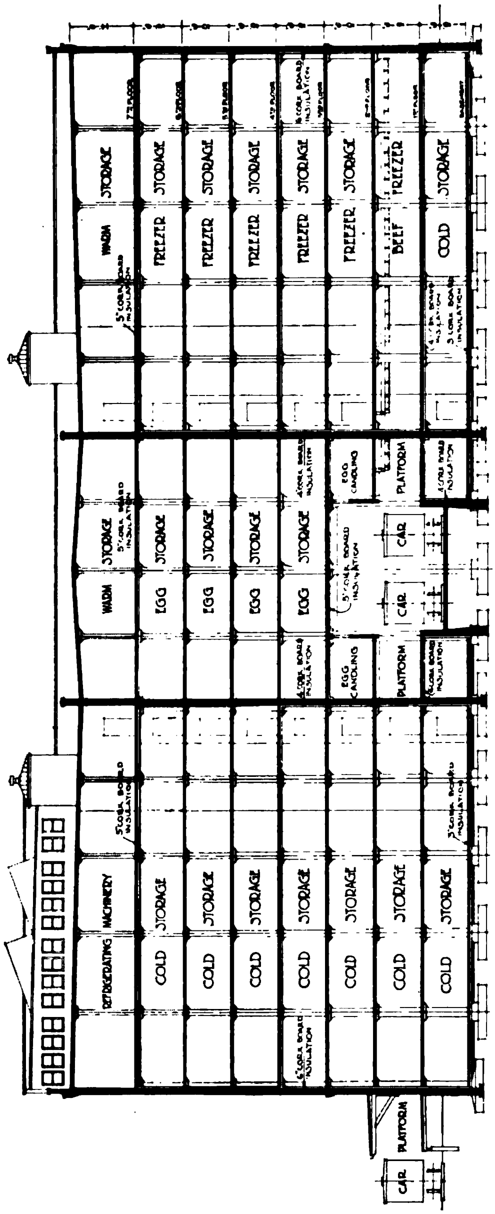


FIG. 81—LONGITUDINAL SECTION—MERCHANTS COLD STORAGE & WAREHOUSE CO.

FIG. 82—COLD STORAGE WALLS UNDER CONSTRUCTION—MERCHANTS COLD STORAGE & WAREHOUSE CO.

The detail of the columns and the manner in which they were placed is illustrated by Figure 83.

The refrigerating machinery is located on the top floor of the south section. Three units of 150 tons refrigerating capacity were provided. The machines were of the absorption type and operated by exhaust steam which was purchased from an adjoining manufacturing plant, which also furnished the current for the electric light and power.

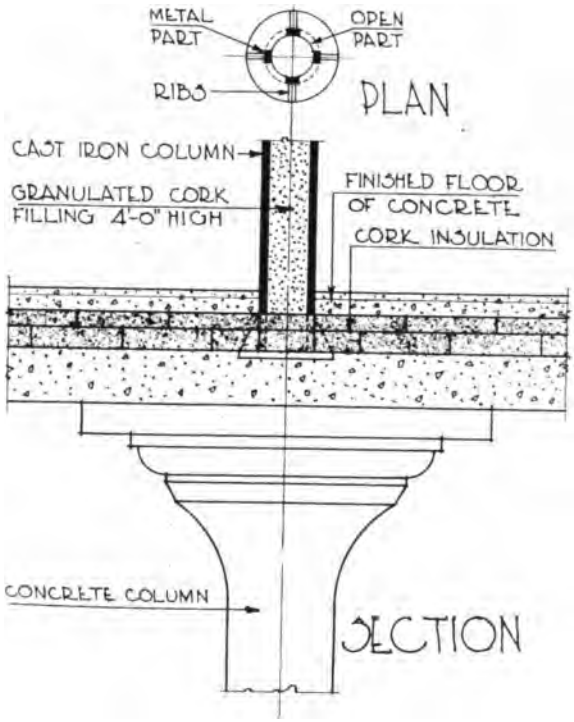


FIG. 83—TOP STORY COLUMN SHOWING INSULATION.

The storage rooms are refrigerated by the circulation of brine which is cooled in three circular, horizontal-type brine coolers, five feet in diameter and eighteen feet long. Calcium brine is used at a temperature of —20° Fahr. in one cooler, zero brine in the second and +15° Fahr. in the third. The brine is handled by three pumps with 8-inch

suction and 8-inch discharge pipes, the pipe decreasing in diameter as it reaches the lower floors, to a minimum of three inches in the cellar. The return line increases in the same proportion until it discharges into two open balancing tanks, six feet in diameter and five feet deep, which are placed above the pumps.

The piping in the rooms is of two inch spellerized steel except in the egg rooms where galvanized pipe is used. All

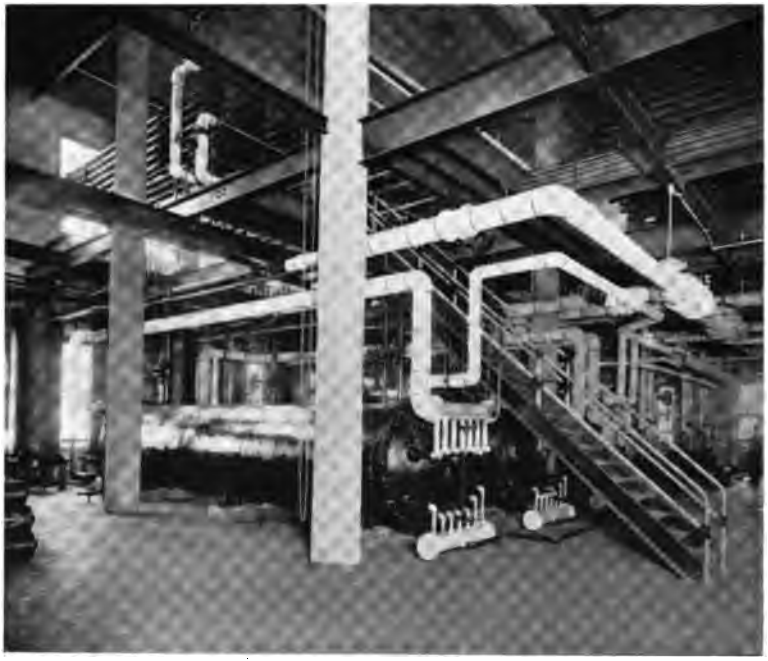


FIG. 84—REFRIGERATING MACHINERY ON TOP FLOOR.
Merchants Cold Storage & Warehouse Co.

pipes are hung from the ceiling in coils of various lengths, which are placed along the outside walls and in the working alleys. The ratios of piping to the cubic space, was figured as follows: Egg and apple rooms, one lineal foot of 2-inch pipe to fifteen cubic feet of space; 15° Fahr. rooms, one foot of pipe to eight feet of space, and sharp freezers, one to three.

The sharp freezer for boxed goods, on the first floor was arranged with racks made of 2-inch pipes. These were placed in tiers from 16 to 20 inches apart horizontally. Working-alleys four feet, six inches wide were provided between each two racks.

The capacity of the refrigerating machine is in excess of the actual requirements in the cold storage building and it should be mentioned that these machines are also being

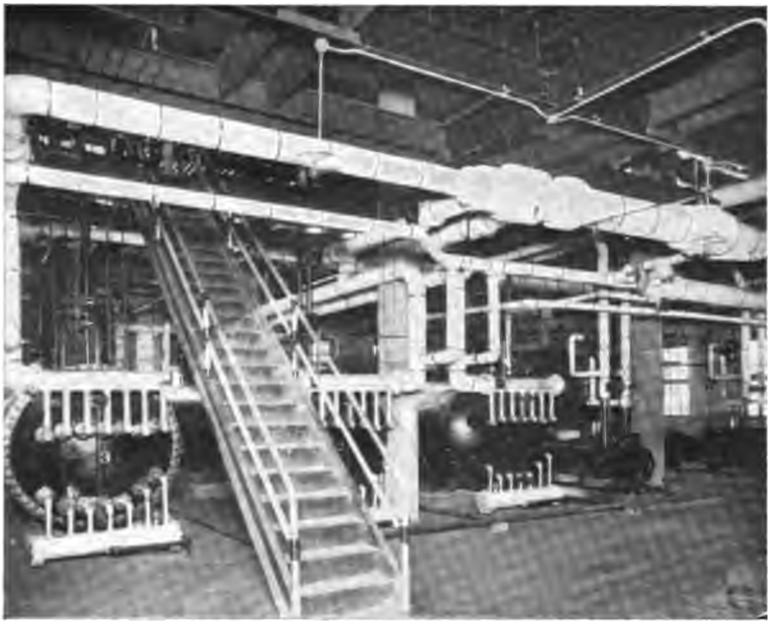


FIG. 85—REFRIGERATING MACHINERY ON TOP FLOOR.
Merchants Cold Storage & Warehouse Co.

utilized for the manufacturing of about 80 tons of ice per day.

The total cubic contents of the building, taking the outside measurements, is 2,775,000 cubic feet.

The available cold storage space is approximately 1,650,000 cubic feet after deducting the space taken up by the construction, railroad tracks, vestibules and the top story.

The cost of building equipment was $425,000.00 The time required for the construction was 14 months. The insurance rate on the building is 21 cents in the south section; 22 cents in the central section and 23 cents in the north section. The rate for insurance on contents in the corresponding sections is 17, 18 and 19 cents.

The refrigerating machinery in this plant includes the most modern equipment in use for cold storage buildings

FIG. 86—REFRIGERATING MACHINERY ON TOP FLOOR.
Merchants Cold Storage & Warehouse Co.

and it may, therefore, be of interest to give a more detailed description of each part of the entire system, in connection with the illustrations, Figures 84 to 87, inclusive.

The three individual units are cross-connected at the anhydrous liquid receivers and at the ammonia pumps. The ammonia absorbers are connected so as to draw gas from three brine coolers or direct from three 50-ton ice-making tanks, located outside of the building.

The ammonia generators are of horizontal type with jointless steel shells, and vertical flat steam coils are arranged for exhaust steam. The absorbers are of the horizontal tubular type with tubes arranged for twenty passes of water.

The exchangers are of the vertical shell type with helical coils, two 75-ton units for each machine.

The pumps are of the single, direct, double-acting, steam type, automatically controlled by the liquid level in

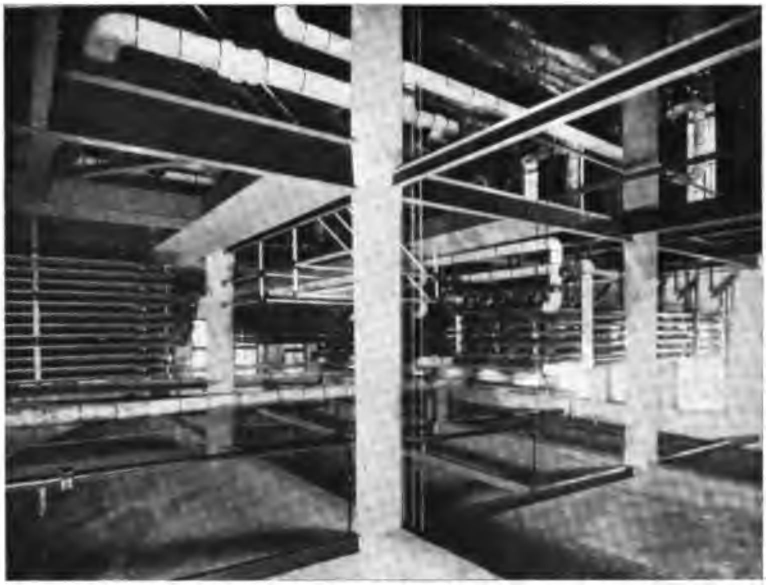


FIG. 87—REFRIGERATING MACHINERY ON TOP FLOOR.
Merchants Cold Storage & Warehouse Co.

the absorber by float valves which open and shut the steam throttle valve controlling the pump.

The brine coolers are of the horizontal, tubular type, arranged for ten passes of brine, with outlet brine as low as 20° below zero, Fahr. The brine pumps are located at the ends of the brine coolers and draw brine from an overhead tank, discharge through the brine coolers, and thence

to the coils in the storage rooms from which the return is carried to a tank directly above the brine coolers.

The balance of the refrigerating machinery is located on a steel platform, above the main engine room.

The rectifiers are of the vertical, flat, double pipe-coil type, consisting of 2-inch and 4-inch pipe.

The condensers are of the double pipe, vertical, flat-coil type, consisting of 1½-inch and 2½-inch pipe.

The weak liquor coolers are of the double-pipe type with 2-inch and 3-inch flat, vertical coils.

The auxiliary pumps for all three machines are steam driven and exhaust into one generator, which is used for the lowest brine temperature. The other generators depend on exhaust from the general power plant.

These machines condense approximately 35 pounds of steam per hour per ton of refrigerating effect and require about two gallons of 60-degree water for the cooling coils, per minute, per ton of refrigeration.

Example No. 2

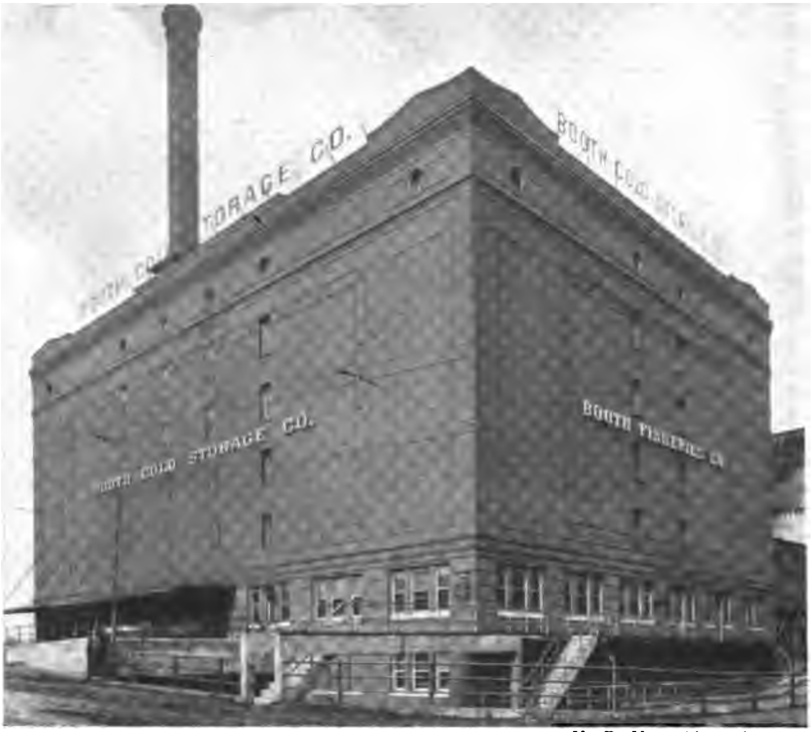
The cold storage plant of the Twin Cities Cold Storage Co., Minneapolis, Minn., is illustrated in Figures 88 to 92.

This plant was completed in 1914, and is, therefore, one of the most recent examples of cold storage construction in the country. It covers an area of 100x140 feet and is eight stories high, with a cellar.

The construction was designed to include two additional stories to be put on at some future time, making the building ten stories in height.

When the erection of the plant was contemplated the owners were confronted with an insurance problem which all cold storage owners are more or less familiar with, namely, that of locating the power plant so that it would not increase the insurance rate on the cold storage building. To avoid having the power plant within the main building, it was decided to place the boiler and engine rooms on the other side of the public driveway, as shown on the first story floor-plan, Figure 89.

The land for the power plant was leased from the City and consisted of a piece of property underneath a viaduct, crossing the railroad yard to the north of the plant. It was necessary to make deep excavations for the boilers and refrigerating machinery, below the present grade, and



H. P. Henschien, Architect.

FIG 88—COLD STORAGE BUILDING.
Booth Fisheries Co., Minneapolis, Minn.

the owners were put to heavy expense in underpinning the abutment wall and columns supporting the viaduct. This greatly increased the cost of the plant, but it reduced the insurance rate sufficiently to warrant the additional expenditure and, in the end, proved a good investment. In order to further reduce the rate the area of the cold storage building was divided into two sections by a brick fire-wall,

so as to avoid the charge imposed on floor areas over 10,000 square feet.

The building is of fireproof construction, with skeleton brick walls and reinforced concrete posts and floors, which are supported independently of the outside walls.

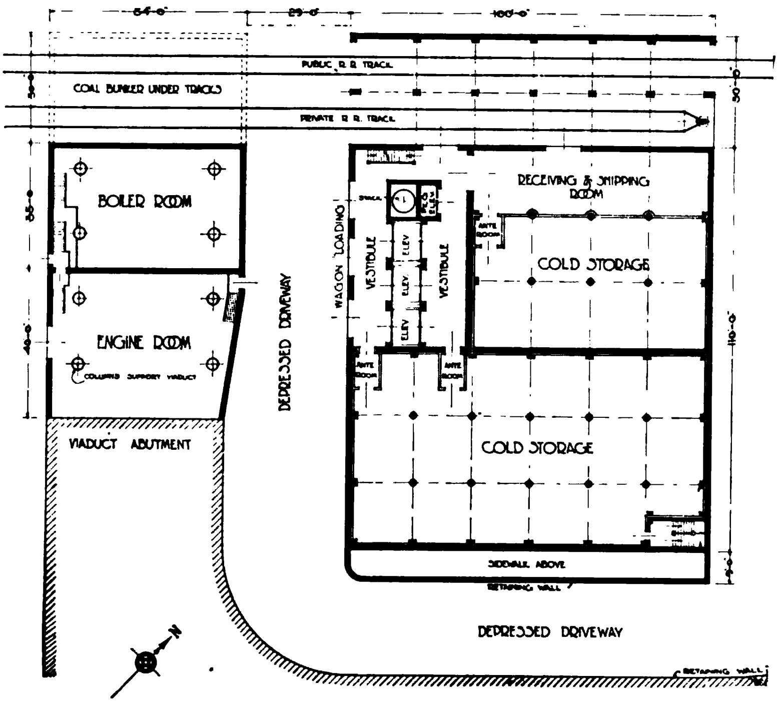


FIG. 89—FIRST STORY FLOOR PLAN—COLD STORAGE BUILDING. Booth Fisheries Co., Minneapolis, Minn.

The flat-slab type of floor construction was used and this was designed for a live load of 200 pounds per square foot, and the columns spaced on 16x18 foot centres. It was necessary to use a very strong mixture of concrete in the columns, in order to reduce their size in the lower stories. By mixing the concrete with one part cement, one part of sand and two parts of crushed rock and using both spiral

and vertical reinforcing steel, the columns were reduced to 30 inches diameter in the the cellar, 28 inches on the first and second stories, 24 inches on the third and fourth stories, 22 inches on the fifth, 20 inches on the sixth and 18 inches on the seventh and eighth stories.

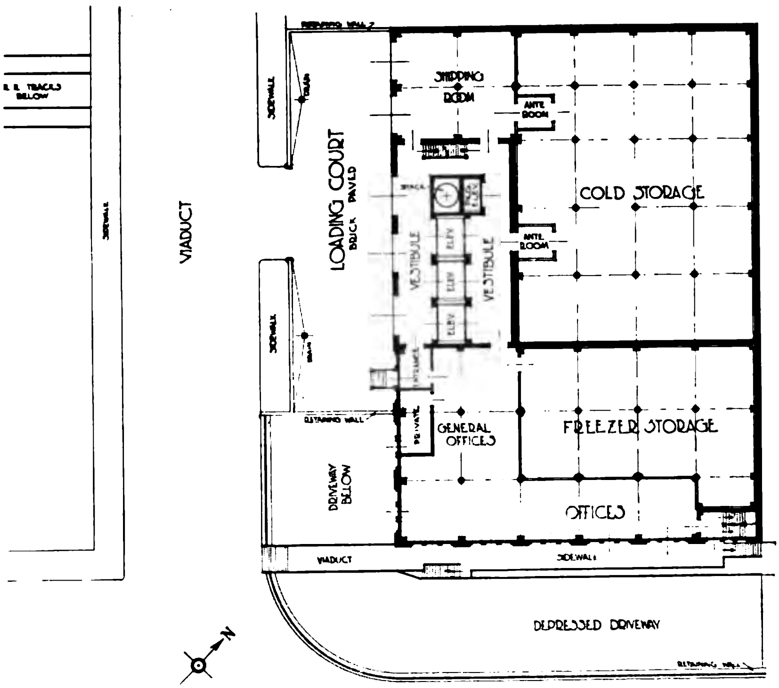


FIG. 90—THIRD STORY FLOOR PLAN.

The roof was built so as to constitute the future ninth story and a filling of cinders was laid on the top of the concrete floor-slab and graded to the downspouts. Over the cinders was placed two inches of concrete as support for the roofing material. Whenever the additional two stories are put up, the cinders can be removed and the present roof-slab used as a floor.

The shipping facilities include two railroad tracks at the north end of the building. One of these, however, is a public siding and can only be used when there is no other traffic demanding service.

The cars are unloaded from the first story floor level into a large receiving and shipping room adjoining the

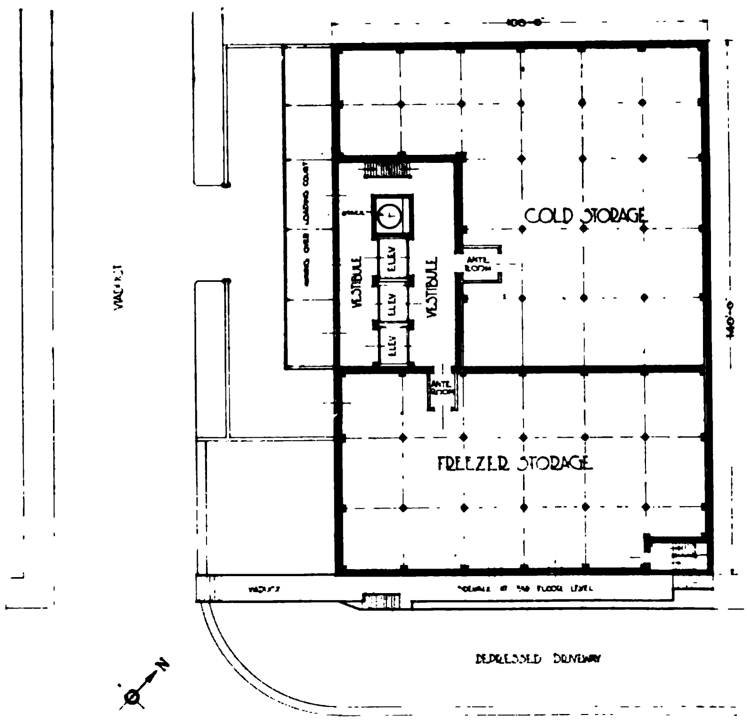


FIG. 91—TYPICAL FLOOR PLAN.

railroad tracks. All wagon deliveries are made from the wagon court at the level of the third floor.

The building is served by three large elevators with eight feet, six inch by nine feet, six inch car platforms, and one package elevator which runs from the first to the third floor only. The elevator, stairs and smoke-stack, are

placed within a large vestibule and arranged so that there is a 10-foot trucking passage on each side of the elevators. The openings in the elevator shafts are protected by automatic safety gates, and the door openings into the storage rooms, by double fire doors. The inner fire door is bolted to the refrigerator door wherever both types of doors are needed.

The building is divided into cold storage and freezer rooms with temperatures ranging from 15° Fahr. below

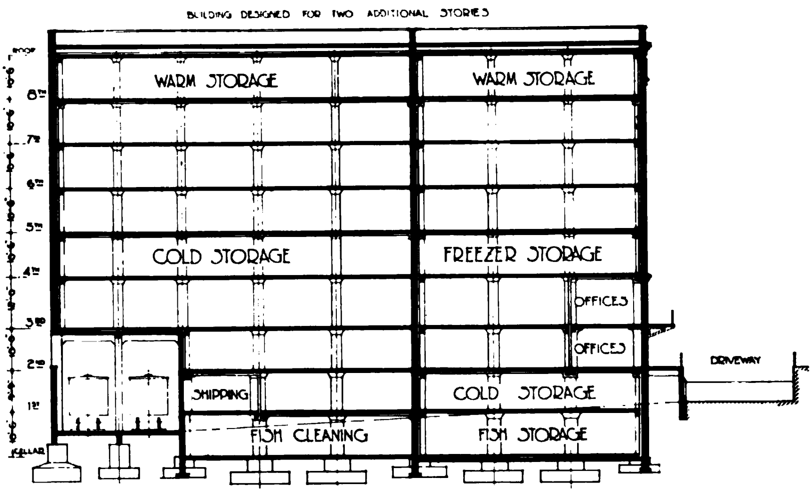


FIG. 92—LONGITUDINAL SECTION.

zero, to 32° Fahr. above. The freezers are placed in one section of the building and extend from the third to the top floor. The other rooms are for egg and fruit storage and are designed for 28° to 32° Fahr. temperatures.

The top floor is not refrigerated and is used as a general dry storage room.

The insulation is of pure cork board, erected in Portland cement mortar and nailed with wooden meat skewers. Six inches of cork was put on the outside walls of the freezers; five inches on the wall between the cold storage and the freezers; five inches on the outside walls of the cold

storage, except on the south wall, which was insulated with six inches of cork.

All ceiling insulation was five inches in thickness and the cellar floor was insulated with three inches of impregnated cork board.

Partitions and columns were insulated with from four to six inches of cork.

The insulation was finished with two coats of plaster, composed of Portland cement mortar and asbestos fibre.

The building is refrigerated by absorption refrigerating machinery and the rooms are cooled by circulation of calcium chloride brine.

The refrigerating equipment which was installed is far in excess of the actual requirements of the cold storage building, since the company furnishes refrigeration to many outside users in the vicinity of the plant.

All piping in the rooms was of 2-inch spellerized steel and the coils were grouped on the ceiling and along the walls. The ratios of piping to the number of cubic feet of space were as follows:

Fish freezing and dipping room.............	1: 2½
Storage freezers for butter and poultry......	1: 5
Quick storage rooms	1: 8
Egg rooms	1:13
Fruit storage rooms........................	1:13
Oyster room	1:25

The gross cubic contents of the building is 1,330,000 feet and the net cold storage space is 850,000 cubic feet. It required 13 months to complete the construction work and the approximate cost of the plant was $300,000. To this should be added the cost of the insulation and piping on the four upper floors, which will not be put in until some future time.

Example No. 3

In Figures 93, 94 and 95 are illustrated a small cold storage building and a 50-ton ice manufacturing plant. The arrangement of the buildings offers exceptional facilities for convenient handling of all commodities.

Two railroad tracks enter the centre of the property so that coal and ice can be handled from one side and cold storage products on the other. By extending the platform along the railroad track, additional loading facilities can be provided.

The plans and sectional drawings show in detail how

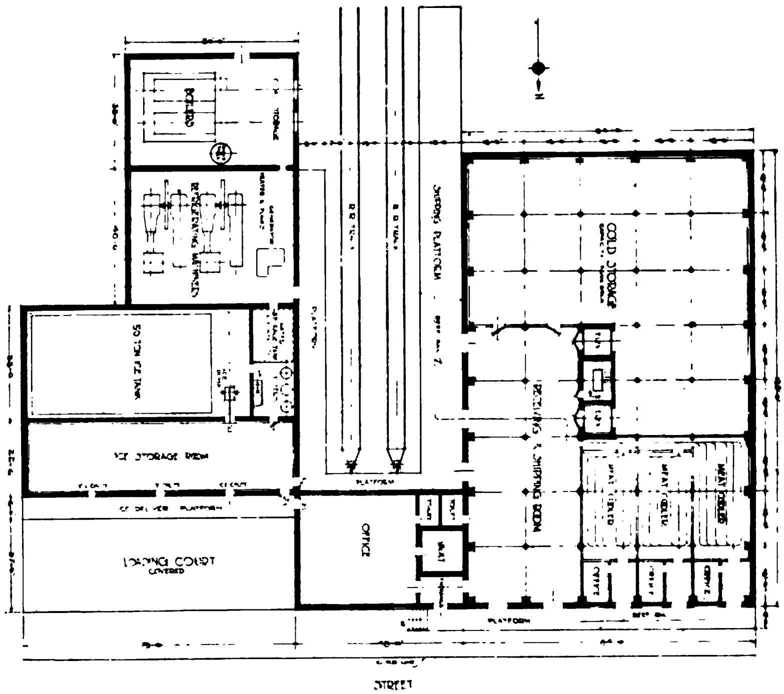


FIG. 93—FIRST STORY FLOOR PLAN—COLD STORAGE AND ICE MAKING PLANT.

each building is arranged so that a further description of the plant will not be necessary.

The planning was done with a view of leaving room for future expansion on at least one side of each building, without having to demolish any of the work already completed.

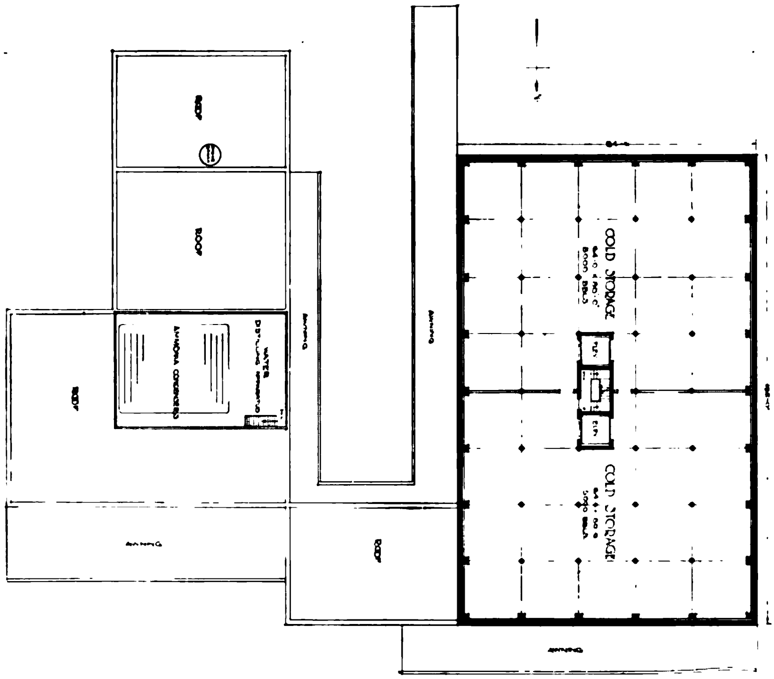


FIG. 94—TYPICAL FLOOR PLAN—COLD STORAGE AND ICE MAKING PLANT.

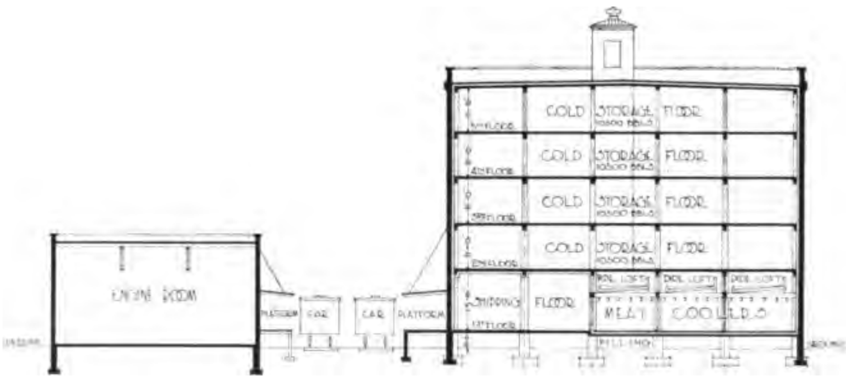


FIG. 95—TRANSVERSE SECTION—COLD STORAGE AND ICE MAKING PLANT.

The capacity of the plant is about 50,000 barrels of apples besides the cold stores for meat or produce shown on the first story plan.

CHAPTER XV

INSULATION

Introduction

When we speak of insulation in connection with cold storage buildings, we mean such materials which are efficient non-conductors of heat and will in practical application limit the transmission of heat between cold storage rooms and their surroundings. It is only within recent years that efficient and durable insulation has come into universal use in packing-house and cold storage buildings.

Along with the improvements in building construction came the demand for more permanent and fire resisting materials. Leading companies, engaged in the manufacturing of cork insulation, began some years ago to make investigations at their experimental stations regarding the relative efficiency of the various materials and methods of construction then in use.

Several of our great technical schools did noteworthy laboratory work along the same lines, and from the results thereby obtained we have received a great deal of valuable information which is now being adapted to the varied conditions found in cold storage construction.

Too often the question of first cost and good salesmanship enter into the final choice of the materials considered. When the buyer is conversant with the results obtained from the various insulating materials in the past, he generally knows what to expect of the material he buys.

In the selection of a satisfactory insulating material there are certain fundamental qualities to be considered and, with one exception, that of heat transmission, these requirements are the same as would be expected of any first-class material used in a modern fireproof structure.

The points to be considered are:

First. Efficiency in resisting heat-transmission.

Second. Durability.

Third. Sanitation.

Fourth. Fire resistance.

Fifth. Structural strength.

Sixth. Cost.

It should be remembered, however, that no insulating contractor will guarantee that his material will maintain the desired temperature in the rooms, and therefore the best is often the only thing which can be depended upon and, in the end, will prove to be the cheapest.

Importance of Good Insulation

The cost of maintaining low temperatures is materially reduced by efficient insulation. When refrigeration must constantly be pumped into a building to keep the temperature from rising, it seems wasteful to use inefficient insulation.

Even the best insulating materials will not prevent the transmission of heat between the inside and outside of a room, on account of the difference in pressure between warm and cold air.

The amount of refrigeration required to hold a room at the desired temperature depends largely upon the efficiency of the insulation, and since good insulation means a daily saving in the cost of operation, it should be considered of as great importance as the refrigerating machinery.

Durability

The cost of insulating a building is always high and for this reason only materials should be considered which are durable and of a permanent insulating value under the most adverse conditions. Many excellent materials of high insulating value, such as mill shavings, mineral wool, and hair-felt, will rapidly lose their efficiency when exposed to the changes in temperature which are always going on between cold storage rooms and their surroundings. This

is caused by their capillary attraction and these materials, by absorbing the moisture from the air, will in a short time, lose their efficiency as insulating media and will have to be renewed. They are only suitable for temporary work or for partitions between rooms of nearly the same temperature.

Sanitation

Insulation forms the inner lining of cold storage rooms and it is essential that it should be sanitary as well as odorless and germ proof. When the insulation or its covering has the least tendency to mold or decay from moisture, there is always the danger that the goods stored will absorb the odors from the insulation.

Commodities such as butter, cream and eggs are easily tainted by foreign odors, while they are held in storage, and it is most important that the insulation should not contain odors which will affect the goods. The insulation of partitions which separate storage rooms must be such as will prevent odors from penetrating from one room to another.

Types of insulation which contain large air spaces and any materials in which rats and other vermin can find harboring places, are highly objectionable and difficult to keep in a sanitary condition.

Fire-Resistance

The use of fireproof construction for commercial and packing house cold storage makes fire-retarding insulation a necessity, heretofore not so considered. It becomes necessary to adopt compact, slow-burning materials covered by plaster or other fire-resisting substances. Concealed air spaces and inflammable materials are not to be considered. Only such types of construction and materials as have been tested and approved by the Board of Fire Underwriters should be used in fireproof buildings.

Structural Strength

The necessity of structural strength in the insulating material is evident where it is used under brine and ice freezing tanks or for floor insulation. Unless there is struc-

tural strength in the material itself to support the load this must be carried by wood or other support of no insulating value.

In partition and ceiling work, the insulation must possess sufficient strength to support its own weight as well as the plaster finish generally put on.

Interior Finish

All material used as insulation requires a covering as protection against injury from goods piled against it, and also to improve the appearance of the rooms. Walls and ceilings are commonly plastered with Portland cement mortar and finished with a hard troweled surface, giving the room a dark grey finish.

When a better appearance is desired, the finished coat of plaster is put on with white cement and given a smooth, highly polished surface which can be further improved by one or two coats of white enameled paint. Glazed white tiling is also extensively used as a finish in high grade meat markets and coolers.

Where wood is used as covering over the insulation it should be of dressed, matched lumber and painted on the back to prevent warping. The outside should be varnished or painted with enamel paint, so as not to absorb any odors from goods stored in the rooms.

Insulating Materials

The old type of insulation, consisting of air spaces separated by one or two layers of sheathing and waterproof paper, is now almost entirely discarded for use in modern permanent buildings.

The present day theory of efficient insulation is based upon using materials in which the air is confined by numerous separate cells, minutely small, and sealed to prevent moisture from entering.

The efficiency of the insulation depends upon how well the confined air can be entrapped and upon its freedom from capillary attraction.

The following materials are most commonly used for insulation purposes in buildings:

Mill Shavings

No other materials have been so extensively used in the past as mill shavings and sawdust. They are still in frequent use for temporary work and in storage houses for natural ice.

Shavings have a high insulating value when kept dry, but, as they absorb moisture rapidly, they soon lose their efficiency and have to be renewed.

They can only be used as a filler between the studding in walls or between floor and ceiling joists, and must be protected by waterproof paper and sheathing.

This type of insulation can be installed cheaper than any other material and will, undoubtedly, remain in use for the cheaper class of construction.

Shavings from odorless woods, such as spruce or hemlock, are preferable to shavings from more resinous woods. Where shavings are not available locally and must be shipped in, they can be bought from manufacturers in compressed bales. These bales measure 14x18x32 inches and weigh 80 pounds.

One ton of shavings, when used as a filler, and properly packed, will occupy approximately 200 cubic feet of space and will cost about five dollars a ton at the mill. Only dry shavings should be used and must be closely packed and the space refilled at the top after the insulation has settled.

Hair Felt

This is an excellent non-conductor of heat, when kept dry. It should not be used in damp places as it will not withstand moisture. It decays rapidly when subject to dampness, and, being an animal substance, will give out offensive odors and attract vermin.

Hair felt is extensively used by refrigerator car builders as it is especially adapted for use where there is much vibration and where many joints would be objectionable. It is inexpensive and easily applied but is not suitable for fireproof construction.

It is manufactured from renovated and dried cattle-

hair and is sold in rolls of from two to six feet in width. The thickness varies from one-fourth of an inch to two inches and the length of the roll is generally 50 feet.

The felt is put up on nailing strips and securely tacked into place with large headed galvanized nails. If more than one thickness is used, the second layer should break joints with the preceding layer.

Mineral Wool

This material is manufactured by subjecting molten furnace slag to a steam jet. It is fireproof, light in weight, and will not pack as easily as mill shavings when used as a filler. It is a good non-conductor of heat when thoroughly dry but absorbs moisture very readily.

Mineral wool furnishes a cheap and efficient insulation, if properly protected from dampness, and is used either as a loose filler in hollow spaces or manufactured into compressed blocks with a fibrous binder and put up with cement or asphalt on walls and partitions.

Mineral wool blocks should be coated with asphalt to make them waterproof and as the bond between a surface covered with asphalt and Portland cement is insufficient to permanently keep the blocks in place, they should be put up in hot asphalt.

Partition work should be erected on wood studding and the blocks nailed on with wire nails driven through tin discs.

Indurated Fibre Boards

These boards are made of paper and wood pulp and are rather densely compressed. The material is a good non-conductor of heat, slow burning and is of fair structural strength. It absorbs moisture when exposed and then deteriorates rapidly. It forms an excellent insulation for partition work and in high temperature rooms of from 45 to 60 degrees Fahrenheit. It is reasonable in price and durable when properly protected from dampness.

The standard size is 18x48 inches and the thickness is from two to three inches.

Lith

This material is made from rock-fibre mineral wool and begummed flax fibre. The finished material is a compressed board 18 inches in width, four feet long and two to three inches in thickness. It is fairly strong, light in weight, and possesses a high insulating value.

Lith is made waterproof by oil vapors and is, therefore, not fireproof, although it is classed as slow burning. It is reasonable in cost and is considered an excellent insulating material when kept free from moisture. It has fair structural strength and can be put up on walls either in Portland cement or with hot asphalt as a binder.

When used for partition work, it should be secured to wood studding with nails placed at the ends and in the middle of each board. It is not recommended for use in ceilings when the insulating material must have sufficient structural strength to support its own weight as well as the plaster finish.

When lith is used on floor insulation, the weight and the floor must be carried by wooden sleepers on account of the small compression strength of the insulation.

Cork Materials

Insulation made from cork materials has been adopted very extensively for all classes of work during the past few years. Cork is the outer bark of the cork-oak and is imported to this country from Spain, Portugal and Northern Africa.

It is made up of numerous cells, see Figure 96, in which the air is confined by the natural gum in the cork. This makes it highly impervious to moisture and consequently this material is most efficient and durable even under the most adverse conditions. It is an excellent non-conductor of heat, light in weight and very slow burning.

Cork as an insulating material in buildings is employed in various forms:

Granulated Cork

This is made from cork cuttings and is used as a filler between double walls and studdings as well as be-

tween floor and ceiling joists. It is considered as the best filler known for commercial uses because of its durability and small affinity for moisture.

It is light in weight, will not pack or settle and is practically odorless. Granulated cork is sold in a number of grades of different degrees of fineness, and is commercially known as follows: unscreened cork, screened granulated cork and regranulated cork.

Unscreened Granulated Cork

This is manufactured from the pure cork waste as it comes from abroad. The cork is ground to pea size and it is then the same material from which the pure cork

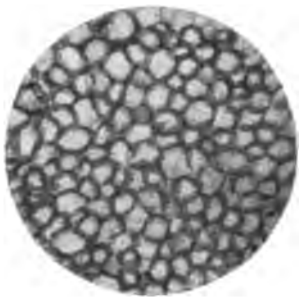


FIG. 96—UNTREATED CORK UNDER THE MICROSCOPE.
Magnified 100 Diameters.

board is manufactured. It is not screened and will weigh about six and one-half pounds per cubic foot and is put up in bags weighing about 110 pounds.

Screened Granulated Cork

This is pure cork waste which is ground and screened through various sized mesh screens. It is not as suitable for use as a filler as the unscreened cork, on account of its even size which allows of too many voids in the filling. It will weigh from six to twelve and one-half pounds per cubic foot, according to its fineness.

Regranulated Cork

This is a by-product of the cork board factories and is manufactured from the waste and trimmings of the baked

cork boards. It is not of equal insulating value to the other grades but costs less. It is sold in two grades, fine and coarse, and by mixing the two together in the proportion of one part of coarse to two parts of fine, the best result is obtained. The weight of this mixture should be seven pounds per cubic foot.

Impregnated Cork Board

This is manufactured from pure cork screenings with a binding material of asphalt or high carbon petroleum pitch. The best impregnated cork of domestic make will contain 95% of cork screenings and is, therefore, an excellent non-conductor of heat. It is not fireproof, but possesses good structural strength and is odorless and reasonable in cost. In the manufacture of this board, the cork is not baked but remains in its natural state, thus retaining its life and vitality. The heat transmission of the best grade of one inch thickness is 7 B. T. Us. per sq. ft. per degree difference, per 24 hours.

These boards are extensively used in places where there is much dampness, such as cellar floors, ice storage rooms, and for insulation under ice freezing tanks and brine storage tanks. When impregnated cork is laid over a concrete floor and covered with two inches of concrete as the floor finish, the construction is approved by the National Board of Fire Underwriters.

Compressed Pure Cork Boards

These boards are made from pure cork screenings without the use of any foreign binding material. The screenings are compressed in cast steel moulds and baked in ovens under a temperature between 600 and 700 degrees Fahr. At this temperature the natural gum in the cork is liquefied and forms a binder for the granules on cooling. Cork boards are manufactured in sizes 12x36 inches and of one, one and one-half, two, three and four inches in thickness. The heat transmission of one inch of cork board is 6.4 B. T. Us. per sq. ft. per degree difference in temperature per 24 hours.

On account of its low heat conductivity, its natural cellular structure and its durability, this board is unsurpassed as an insulating material. It is structurally strong and very slow-burning.

When erected in Portland cement mortar and plastered on the outside, cork board insulation is approved by the National Board of Fire Underwriters and can be used

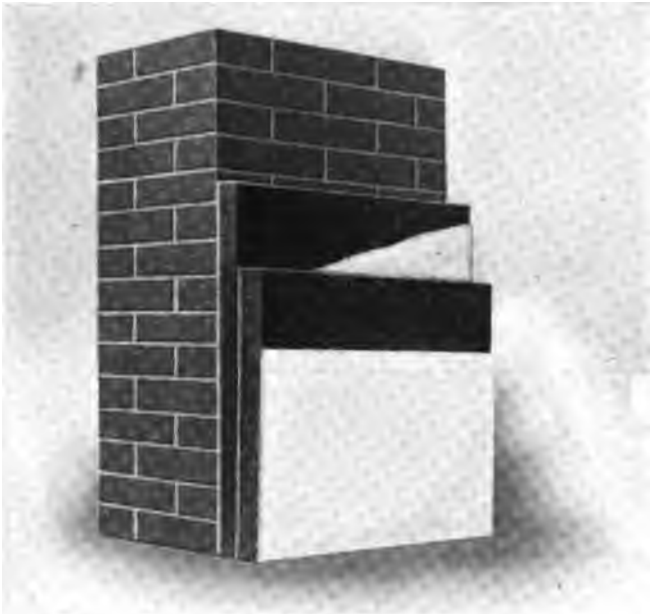


FIG. 97—CORK BOARD INSULATION ON BRICK WALL.
Approved by National Board of Fire Underwriters.

in fireproof buildings (Figure 97). The cost is reasonable, considering its durability and the results obtained.

Weights	1 -inch	thick	1 lbs.	per sq. ft.
Weights	1½-inch	thick	1.4 lbs.	per sq. ft.
Weights	2 -inch	thick	1.7 lbs.	per sq. ft.
Weights	3 -inch	thick	2.4 lbs.	per sq. ft.
Weights	4 -inch	thick	3.2 lbs.	per sq. ft.

As a rule they will not vary more than 5% from the above weights.

Construction Details

The illustrations of different types of insulations, in this chapter, show designs that are adapted to the construction of modern buildings and are typical of the best accepted practice.

The author has named cork, in preference to any other insulating material, in the belief that cork will give a better return for the money expended.

The thickness of cork required to properly insulate a room for a given temperature, depends upon the climatic conditions and the exposure of the building, as well as the type of building construction used.

It is good practice to increase the thickness one inch on the south and west walls, on account of their exposure to the sun.

Ordinary cold storage rooms with temperatures ranging from 30° to 36° Fahr. require from four to five inches of cork board insulation.

Freezer rooms should not have less than six inches, or more, depending upon the climate.

It should be remembered that the function of a cold storage room is to maintain a desired temperature within the room during all seasons of the year. In localities where there are prolonged periods of very low temperatures, the determining factor in the design of the insulation should be the extreme cold on the outside of the building.

The insulation is too important a factor in cold storage construction to be designed by general rules. We have found in insulation work as we have found in everything else that a "rule of thumb" method is not only obsolete but unprofitable.

There should be a rational selection of the amount of material to be used in insulating, otherwise there is danger that the insulation will be insufficient or needlessly heavy and therefore needlessly expensive.

The best results are obtained, both in efficiency and economy, when the insulation work is handled by someone who has a wide knowledge of the value of the different

insulating materials as well as experience in their practical application:

The usual method of putting up insulation in cement mortar is to cover the entire back surface of the board with mortar before placing it in position. The boards are then firmly pressed into place on the wall and the edges and sides left free of mortar, so as to leave as small joints as possible.

When an asphalt binder is used, the boards are dipped, on one side and both edges, in a pan filled with hot asphalt and are then nailed in place. The cork should be scored on both sides to give a good key for the plastering. This is done at the factory without charge. It is, however, generally omitted by the manufacturer unless the specifications call for it.

The finish applied to the insulation will depend upon the use to which the cooler is put. An inexpensive finish can be had with Portland cement mortar. This should be applied as two-coat work, troweled to a hard, smooth surface.

Keene's imported white cement, or glazed and enameled tiles, are used where a more elaborate finish is desired.

Double Wall Insulation

The type of wall insulation shown in Figure 98 consists of two brick walls, placed from eight to twelve inches apart, the width depends upon the thickness of insulation required.

The space between the walls is filled with a loose insulating material such as granulated cork, mineral wool, or mill shavings.

The outside wall is the building wall proper and is constructed ahead of the inside retaining wall and the two are tied together with iron anchors.

The four-inch wall is built as a panel between the columns and is supported by the concrete construction at each floor level.

One wall-tie is generally placed in the centre of each panel to prevent the wall from buckling under the pressure from the insulating material behind.

When the columns are omitted and the retaining wall is continuous from one end of the building to the other, the anchors should be placed not over six feet apart.

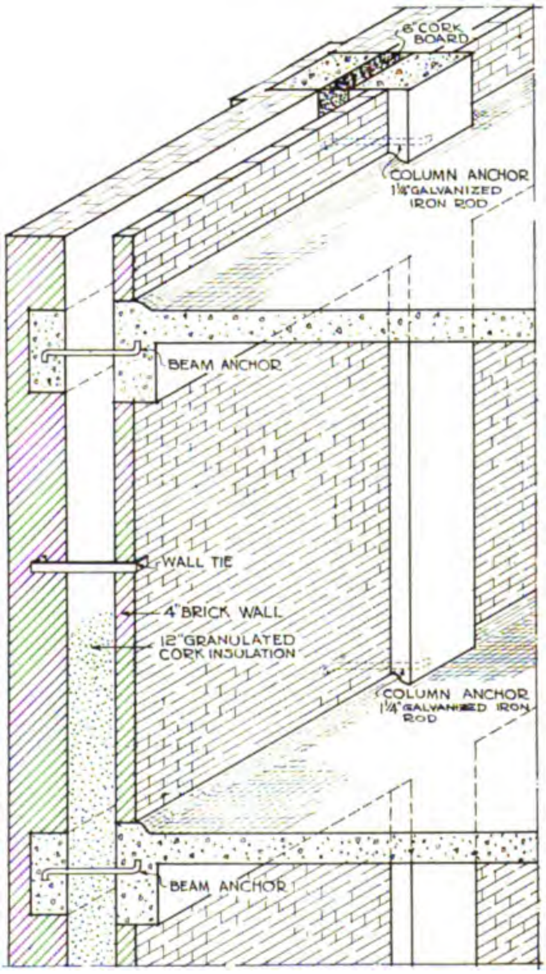


FIG. 98—DETAIL OF DOUBLE WALL—GRANULATED CORK INSULATION.

The brick should be laid up in Portland cement mortar and the wall placed flush with the outside face of the concrete floor beams.

The space between the columns and the outside wall is insulated with cork-board from four to six inches in thickness. This is done to bring the columns nearer to the wall and still have sufficient insulation between them to prevent heat transmission.

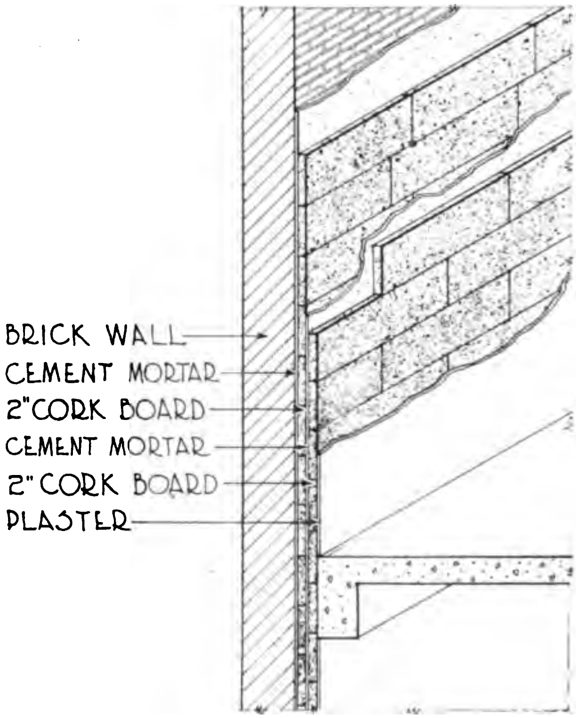


FIG. 99—DETAIL OF BRICK WALL INSULATION.

When the building wall is of concrete skeleton construction, the cork between the inside and outside columns may be placed in the wood forms and the concrete poured afterwards.

The wall must be painted on the inside with asphaltum or other waterproof paint in order to protect the insulation from dampness. This should be carefully done as it is

practically the only means of effectively preventing the moisture from entering the insulation.

Openings should be left in the cellar, about every eight feet, so that all loose mortar or debris which is dropped between the walls can be removed.

In buildings of ordinary height, or from three to five stories, the insulating material can be poured from the top, after the walls are built.

FIG. 100—ERECTING CORK BOARD INSULATION ON BRICK WALLS.

The insulation will bridge itself, at times, at some point above the solid fill and to prevent this a brick should be tied to a long string and kept moving along the wall until the filling is done.

This type of wall insulation is one of the earliest in use and is now almost discarded for the more efficient and economical type illustrated by Figure 99.

The additional room taken up by the inside wall and the wide, hollow space, becomes too wasteful in a building which occupies high-priced property. There is also danger of the inside wall being damaged in case of fire causing the insulating material to run out from the floors above.

Wall Insulation

In Figures 99 and 100 are illustrated the usual method of applying cork board insulation to brick walls. The first layer of cork board is applied with Portland cement mortar and set so that the vertical joints are broken.

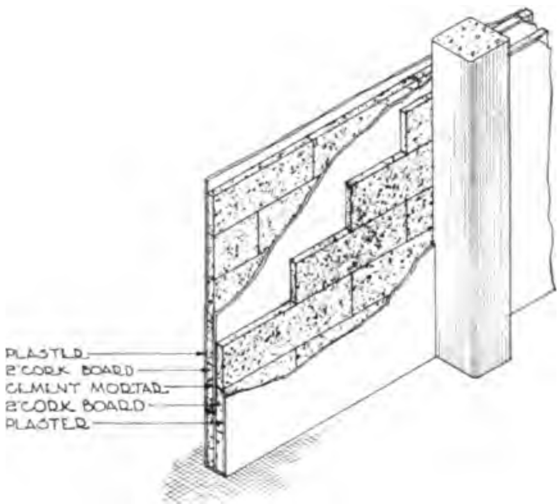


FIG. 101—DETAIL OF INSULATED PARTITION—CORK BOARDS ERECTED IN CEMENT MORTAR.

The second layer is cemented to the first and placed so that all joints between the two layers of cork board are broken. The cork is nailed together with hickory meat-skewers, driven diagonally through the outside boards and into the first. The insulation is plastered and given a hard, sanitary finish.

Insulated Partitions

In Figure 101 is illustrated an insulated partition built of two thicknesses of cork boards cemented together with

½-inch Portland cement mortar and finished on both sides with cement plaster applied on galvanized metal laths.

The joints between the two layers of cork should be broken both ways and the boards nailed together with hickory meat-skewers.

Solid cork partitions built in this manner and placed against the columns of the building, can be erected as high

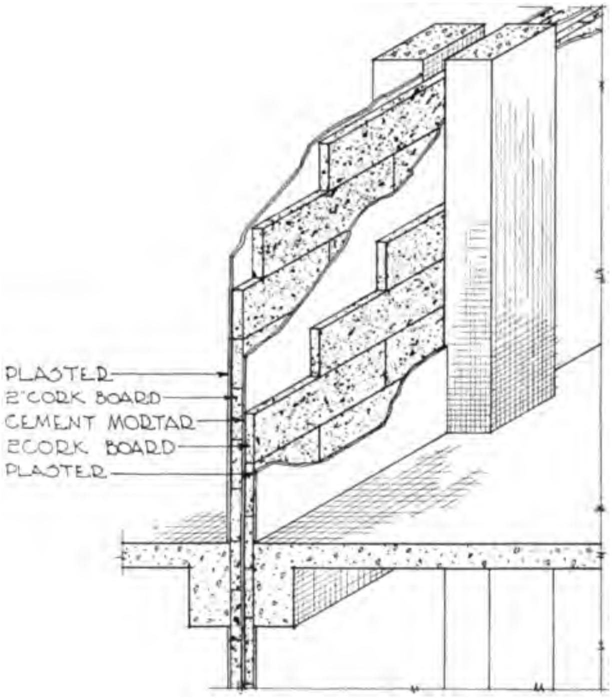


FIG. 102—DETAIL OF INSULATION PASSING THROUGH FLOOR.

as fifteen feet and require no additional bracing. They take up less room than any other type of construction and are more nearly fireproof than partitions erected with wood studding. The metal lath may be omitted to reduce the cost of construction, but should be used in all first-class work.

In Figure 102 is illustrated a solid cork partition used between the freezer and the cold storage rooms.

This partition is continuous from one end of the room to the other and is continued up through the floor from the story below. The columns and floor beams have been split in two to allow the partition to pass through.

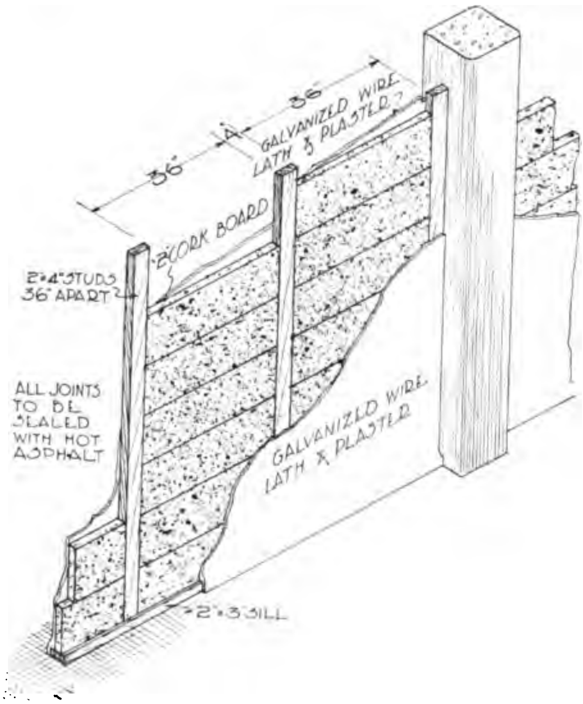


FIG. 103—DETAIL OF INSULATED PARTITION—CORK WITH WOOD STUDDING.

There is no contact between the beams and columns in the two kinds of storage with the exception of one anchor-bolt at the floor line and one in the middle of the columns.

The partition is erected with the same materials as described with Figure 101.

The partition shown in Figure 103 is built of two inch cork boards nailed between 2x4-inch studding, spaced 36 inches apart and plastered on both sides with Portland cement mortar over galvanized metal laths.

The studding is first put up and nailed to the 2x3-inch sill laid on the concrete floor and to the 2x4-inch plate at the ceiling line.

The cork boards are placed lengthwise between the

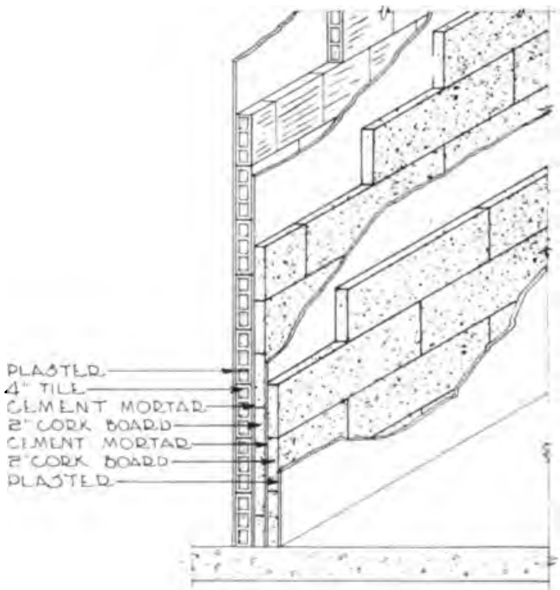


FIG. 104—DETAIL OF INSULATED PARTITION—CORK AND TILE.

studding and toe-nailed at each end with three-inch galvanized nails.

This partition is used between cold storage rooms of nearly equal temperature or to enclose rooms carried at 50° Fahr.

Where the partitions are to be used temporarily and are to be removed at some future time, the plastering should be omitted and the cork boards covered on both sides with waterproof insulating paper and finished with yellow pine

or hardwood boards, painted on the back, and varnished on the outside to keep out moisture.

In Figure 104 is illustrated an insulated partition built

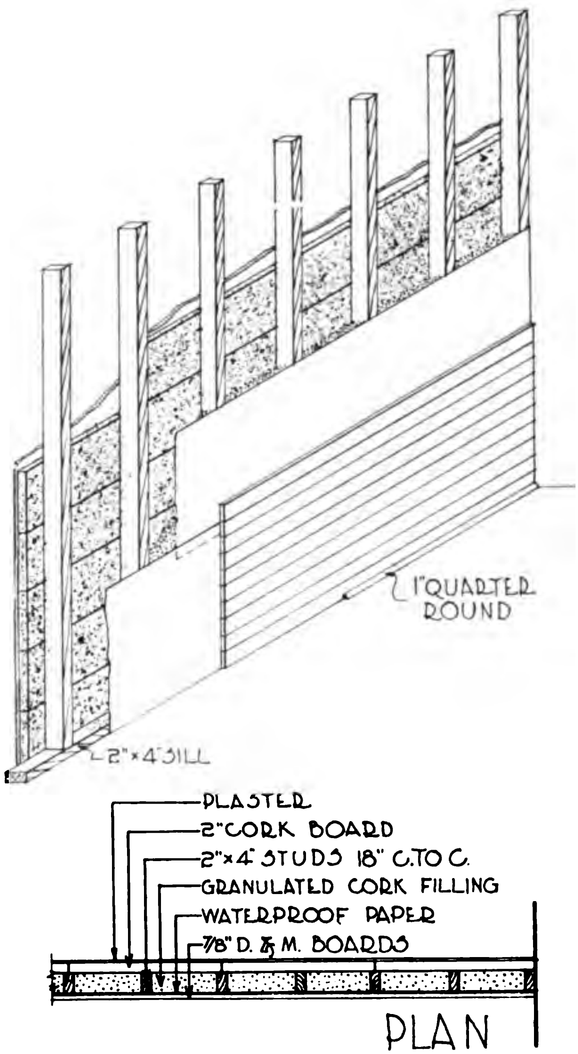


FIG. 105—DETAIL OF INSULATED PARTITION—GRANULATED CORK FILLING BETWEEN STUDDING.

of 4-inch tile with two thicknesses of cork boards on the cold storage side.

This partition is recommended for use in rooms with high ceilings, fifteen feet or over, where fireproof construction is necessary.

The cork is put up in Portland cement mortar in the same manner as described for the insulation of brick walls. The tile should be plastered on the outside to give a better

FIG. 106—TWO LAYERS OF CORK BOARD ERECTED AGAINST WOOD STUDDING.

appearance and effectively close up any void in the joints.

Where the floor construction is strong enough to support the load, four inches of brick can be used instead of the tile.

In Figures 105 and 106 is illustrated a partition often used in wholesale markets where wood construction is used.

This partition is easily put up and practically as efficient as if made of four inches of solid cork. It can be used

to advantage where the partition is required to support the load from the ceiling construction above.

The 2x4-inch studding is put up on an 18-inch centre and toe-nailed at the top and bottom to a 2x4-inch plate

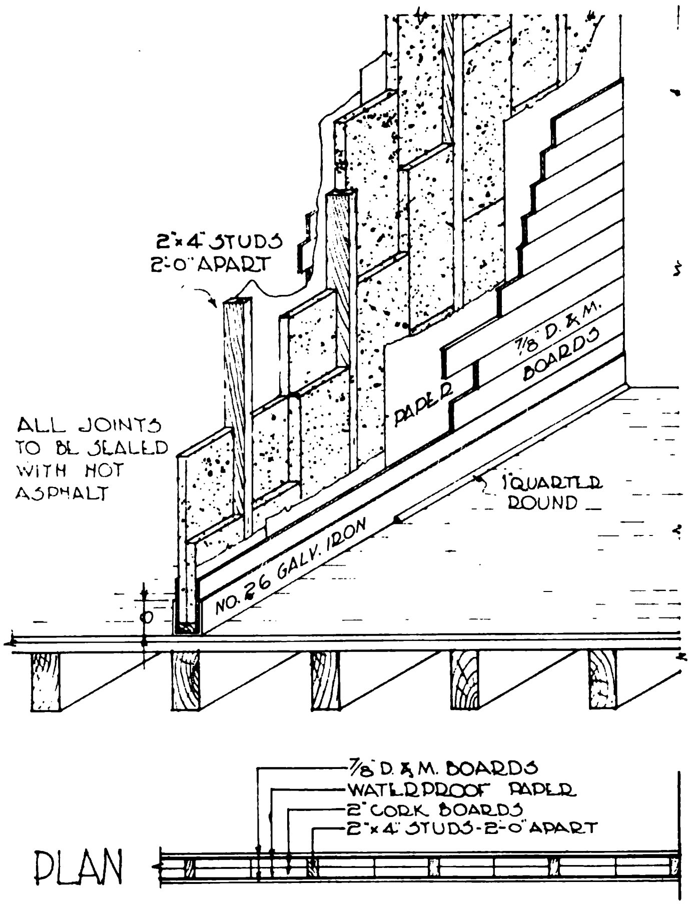


FIG. 107—DETAIL OF INSULATED PARTITION—CORK WITH WOOD STUDDING.

and sill. The studs are covered on the outside with waterproof paper and 7/8-inch dressed and matched boards.

The cold storage side is insulated with 2-inch cork board nailed with galvanized wire nails and the space between the studs is filled with granulated cork.

The finish on the cork board should be of plaster or glazed tile, if the floor of the building is rigid enough to prevent cracking of the finish, due to vibration under trucking or moving loads.

Where partitions of this type are built one above the other, from the basement and up to the first and second floors, the studding should be continuous and not supported on the wooden joists at each floor level.

When built in this manner, the partition will not sag with the floor or pull away from the ceiling level, which is a common occurrence where the partition is supported directly on the floor construction.

In Figure 107 is illustrated an insulated partition with two thicknesses of 2-inch cork board placed between 2x4-inch studding and covered on both sides with waterproof paper and by ⅞-inch dressed and matched boards. The joints between the studding and the cork board must be carefully sealed with asphalt to prevent the passage of air and moisture through the joints.

This partition is not recommended for permanent work unless a great deal of care is taken with the erection and all joints are carefully sealed up. It has the advantage of requiring less space than the partition shown in Figure 101 and can be used where a solid cork partition is impractical.

The galvanized iron covering shown on both sides of the partition at the floor level line is put on to protect the woodwork against water on the floor and to prevent rats from gnawing through from the outside.

Ceiling Insulation

In concrete buildings where the ceilings are insulated with cork board, the insulation should be made a part of the building construction and not put up after the building is erected.

There is a decided advantage when the cork is laid in the forms and the concrete floor is poured on top, as

shown in Figure 108. The two materials are then integral and a better job is obtained at a smaller cost of labor. The work can be more closely inspected during the construction, which is always important where first-class work is desired. The cork can be laid in the forms by ordinary labor if the work is done under the direction of an experienced foreman.

FIG. 108—INSULATING CONCRETE CEILING BY PLACING CORK BOARD IN THE FORMS BEFORE CONCRETE IS POURED.

When the insulation is applied on the ceiling after the building is completed, the cork board must be put up from a scaffold placed on the floor below and this requires experienced and high priced labor. The work is done under conditions requiring artificial light by which only a superficial inspection can be given to the materials and work-

manship. In Figure 109 is illustrated an insulated ceiling after the wood forms have been removed, and with the cork ready for plastering.

In Figure 110 is illustrated a concrete ceiling insulated with two thicknesses of two-inch cork board and finished with Portland cement. The framework is first erected and made four and one-half inches deeper than would otherwise be necessary, and the beam boxes are made of a size which will hold the insulation on all three sides of the beam.

The first layer of cork is placed over the form boards

FIG. 109—CORK BOARD ON CEILING READY FOR PLASTERING.

and laid so that all transverse joints are broken. Over this the second course of cork board is laid in ½-inch Portland cement mortar and nailed to the underlying cork with hickory meat skewers.

The boards must be placed so that all joints in the two courses of cork are broken. The reinforcing steel is then placed on top of the cork and the concrete floor poured to the required depth.

When the floor has hardened enough to permit the removal of the forms, the cork ceiling is plastered from below. The strength of the bond between cork board and concrete erected in this manner, has been tested and the result showed that it required an average of 344 pounds per square foot to break the bond between the two materials.

The author has employed this method of construction in many instances and always found it satisfactory and economical.

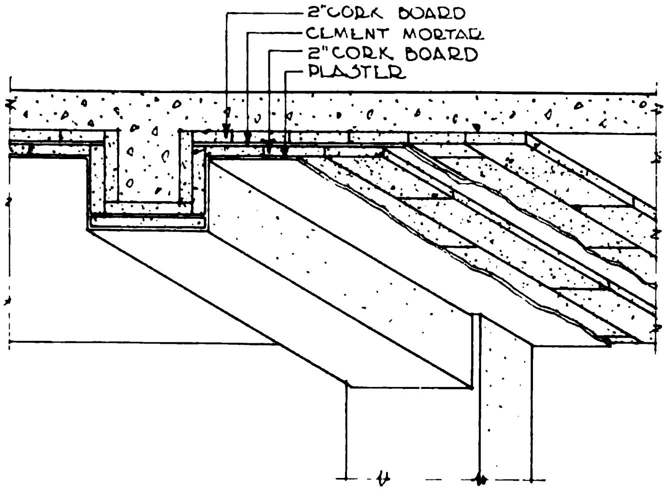


FIG. 110—DETAIL OF INSULATION ON CONCRETE CEILING.

Precautions should be taken, however, to avoid any rough handling or dropping of the reinforcing steel on the insulation at the time the steel is laid, otherwise the cement mortar between the two layers of cork board might easily be broken, causing the bottom layer of cork to drop off after the form work has been removed.

The ceiling insulation illustrated by Figure 111 is frequently used in buildings of ordinary wood construction or where an old building of this type is insulated for cold storage purposes.

To the underside of the floor, or ceiling joist, is nailed a course of 7/8-inch dressed and matched boards, either hemlock or spruce, and to this is applied two layers of waterproof insulating paper laid with a 3-inch lap and all joints sealed with hot asphalt.

The first thickness of cork board is securely nailed to the ceiling with large head galvanized barbed wire nails and erected so that all transverse joints are broken. The second layer of cork is put up with Portland cement mortar or hot asphalt and additionally secured by being nailed to the first course.

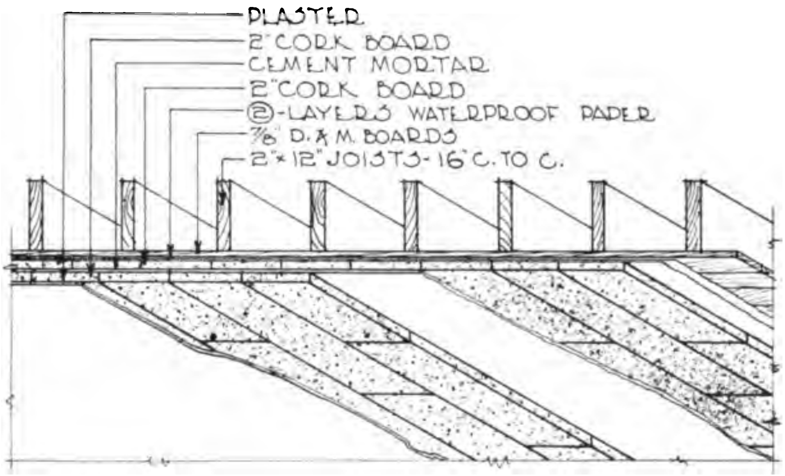


FIG. 111—DETAIL OF CEILING INSULATION.

All joints must be broken and made tight between the two layers of cork. A finish of Portland cement mortar is generally applied over the cork. The objection to this method of applying insulation is the probability of moisture collecting between the joists (where there is a floor above). There being no means of ventilation, the lumber will be soon attacked by wood destroying fungi.

It is therefore advisable to place the cork on the floor above, when this can be done, and leave the joists exposed on the underside.

FLOOR INSULATION

Cellar Floor

Where cellar floors are insulated (Figure 112) the excavation should be carried down far enough to allow for an 8-inch cinder fill being laid over the entire floor area.

When the ground is water-soaked and badly drained, it is best to place drain tiles under the cinder fill and connect the tile to the sewer or to a cesspool in which the overflow pipe connects with the sewer.

Over the cinders should be laid a base floor of 3-inch

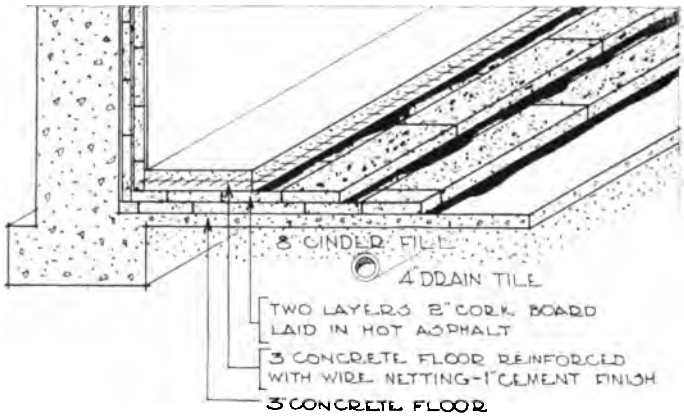


FIG. 112—DETAIL OF CELLAR FLOOR INSULATION.

concrete which should be carefully graded to all drain outlets. The concrete floor is then mopped with hot asphalt and the first layer of cork board put down while the asphalt is still hot.

In a first-class job the joints between the cork are poured full with asphalt in order to fill all possible voids between the cork and the concrete base. This will require a lot of asphalt, unless the floor has been evenly graded.

The second layer of cork board is laid in the same manner as the first and the joints between the two layers should be broken.

The top surface of the insulation is given a mop coat of asphalt or waterproofing material before the concrete wearing floor is put down. This is made from three to four inches thick which includes the 1-inch wearing surface of cement mortar.

The concrete is mixed in the proportion of one part of Portland cement to two parts of sand and four parts of crushed rock ½-inch size.

The mortar for the finish should be of one part cement to two parts of torpedo sand or granite screening. In order

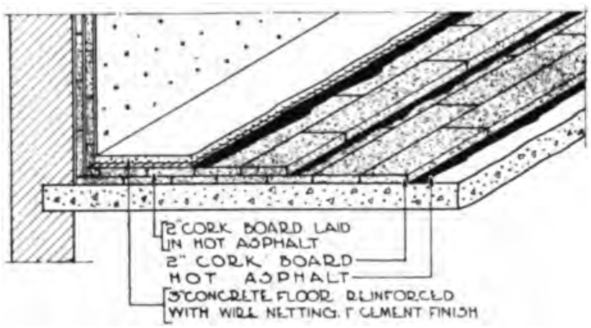


FIG. 113—DETAIL OF FLOOR—4" CORK BOARD WITH CONCRETE FINISH.

to prevent the concrete from cracking, it should be reinforced either with ½-inch steel rods, wire cloth or poultry netting, laid one inch below the top surface.

In Figure 113 is illustrated 4-inch cork insulation laid over a reinforced concrete floor in the same manner as described for cellar floors.

In Figure 114 is illustrated an insulated floor with wood finish. The cork is laid in asphalt in the same manner as described for cellar floors, except that wooden nailing strips are inserted in the top layer of cork. The strips are made of 2x4-inch yellow pine or other hard wood which will hold nails firmly.

They are spaced 12 inches apart where the wearing floor is of ⅞-inch material and 24 inches apart with 1¾-

inch, or heavier, flooring. This spacing allows one or two sheets of cork to be placed between the nailing strips with-

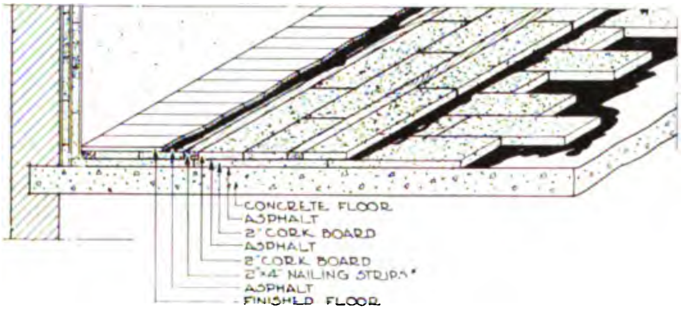


FIG. 114—DETAIL OF FLOOR—FOUR INCHES OF CORK BOARD WITH WOOD WEARING FLOOR.

out cutting the cork. The top of the insulation should be mopped with asphalt or covered with waterproof paper before the finished floor is laid.

Roof Insulation

The method of insulating the roof illustrated by Figure

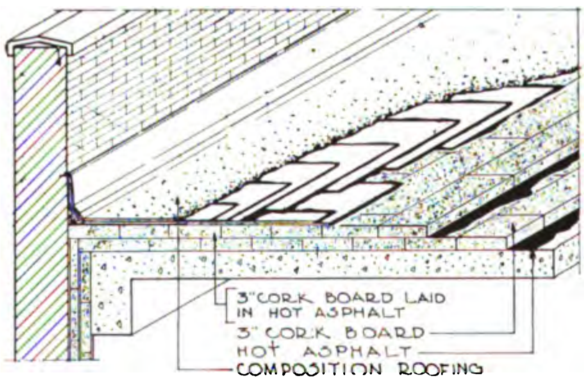


FIG. 115—DETAIL OF ROOF INSULATION.

115 is now generally used in buildings where the top floor is used as cold storage. It eliminates the air space be-

tween the roof and the ceiling of the top floor and reduces the height of the outside walls.

The construction of the roof must be similar to that of the floors below and the wall insulation is extended up to meet the insulation on the roof.

The thickness of cork should not be less than six inches, and over freezer rooms eight inches of cork is frequently used.

The cork is laid on the roof slab in hot asphalt with the joints broken between the two layers and all voids filled solid with asphalt and cork dust.

The top surface is mopped as soon as the work is finished, in order to protect the cork from rain water until the finished roof is applied.

Insulation on Roofs to Prevent Condensation of Moisture on Ceilings.

Concrete roofs will sweat in cold weather due to condensation of moisture on the ceiling. When the warm air of the room comes in contact with the cold roof surface, it gives up its moisture, which forms in drops of water on the ceiling. This condition is objectionable in packing house buildings where the top floor is heated, and the roof surface should be covered with sufficient insulating material to prevent the concrete from being chilled. Two inches of impregnated cork board will be sufficient to overcome this trouble in an ordinary climate. The cork should be laid over the roof surface in hot asphalt and the finished roof put down over the insulation.

Where the roof construction is of wood, the insulation will not be required, if the roof boards are 1¾-inches in thickness and are covered with a felt and gravel roofing.

Brine Tank Insulation

In Figure 116 is illustrated the usual method of insulating a steel brine tank. The tank is located in the corner of a room and set 12 inches away from the walls, leaving a space on two sides which is filled with granulated cork. The remaining two sides are insulated by building a partition 12 inches away from the tank and filling this space with

granulated cork. The floor under the tank is insulated with two layers of 3-inch impregnated cork board laid in hot asphalt. The tank is placed directly on top of the insulation in a bed of asphalt one-eighth of an inch thick.

The partition is built of 2x4-inch studding set 24 inches on centres and covered on the outside with one thickness of D and M sheathing, laid horizontally and nailed to the

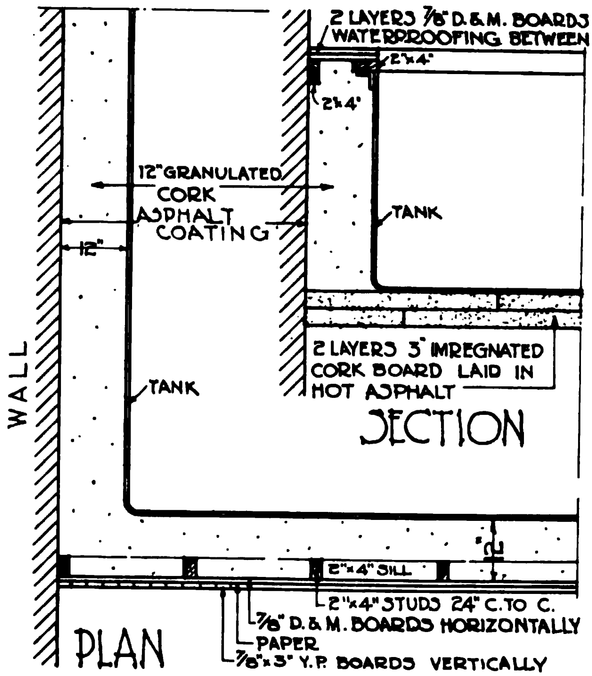


FIG. 116—DETAIL OF ICE TANK INSULATION.

studs with galvanized nails. Over this is placed a layer of waterproof paper and an outside covering of yellow pine boards, 7/8x3 inches. These are set vertically and should be painted on the back before being put up.

The brick walls should be mopped with asphalt or coated with a waterproof paint before the tank is put in place.

The insulation should be covered at the top of the tank with two thicknesses of yellow pine boards with waterproofing between them, so as to keep the moisture away from the insulation.

Around the ice freezing tanks, where there is much spilling of water in connection with the ice-making, there is frequently trouble from water leaking down into the

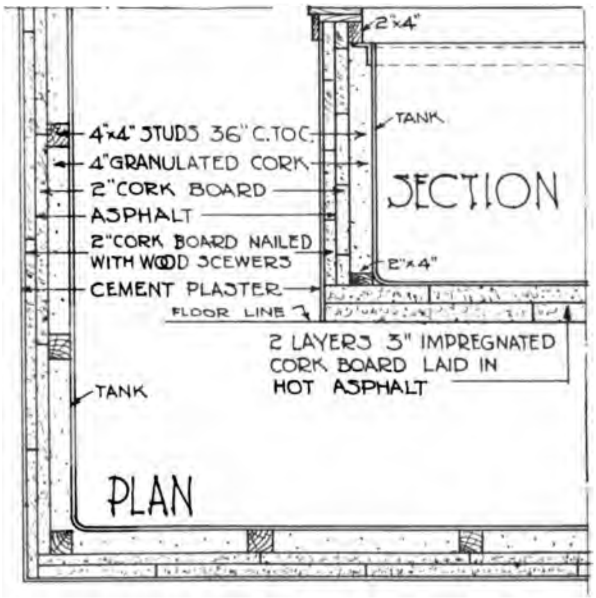


FIG. 117—DETAIL OF ICE TANK INSULATION.

insulation. If the top cover is properly put on, this will not occur.

The joints at the wall line should be caulked with pitch and oakum and flashed with galvanized iron and the cover set so that the water will drain away from the wall and back into the tank.

In Figure 117 is illustrated another method of insulating an ice freezing tank.

The floor is laid in the same manner as described before and extends eight inches beyond the sides of the tank.

After the tank is set in place and riveted up, the insulation of the sides is started by placing 4x4-inch studs against the tank, on 36-inch centres. The studs are toe-nailed to a 2x4-inch sill, laid on the floor, 2-inch cork board is then nailed to the studding, with galvanized wire nails, and a second layer of cork board applied to the first layer with hot asphalt and securely nailed with wood skewers, driven diagonally through both layers of cork. The outside of the insulation is covered with Portland cement plaster. The space between the studding is filled with granulated cork and covered at the top of the tank with a wooden cover. This is made of two thicknesses of yellow pine boards, with waterproof paper and asphalt between.

A frequent mistake in insulating tanks is to make the thickness of the insulation under the tank insufficient for the requirements. Brine in freezing tanks will average 12° and 14° Fahr., and at this temperature the cold will quickly penetrate into the underlying soil unless the insulation is sufficient to prevent the leakage.

A striking example of such loss of refrigeration was discovered in an old ice factory in Chicago, where the insulation under the tank consisted of 3-inch imported, impregnated cork and 1 inch of pitch. After the tank had been in service for eight years, it became necessary to make excavations for an adjoining building and it was then found that the ground was frozen for 17 feet below the bottom of the tank.

In Figure 118 is illustrated the laying of cork under an ice freezing tank.

Pipe Covering

Brine headers should be insulated when they run outside of cold storage rooms, otherwise their efficiency is partly lost in conveying the chilled brine to the cold storage rooms. It is also necessary to insulate the ammonia gas headers from the rooms back to the machine.

The usual method of insulating is to put on a sectional covering of cork or hair felt, which can be obtained in

sizes to fit any diameter of pipe and fitting. Care should be exercised in applying the insulation; small air leaks mean rapid destruction of the insulation at that point. When the outside air comes in contact with the cool pipe it deposits moisture which freezes on the pipe and the ice forming under the insulation will, in a short time, force the covering off entirely.

FIG. 118—LAYING CORK INSULATION UNDER FREEZING TANK.

The hangers should be applied on the outside of the covering and there should always be a piece of galvanized sheet iron next to the insulation. If the hanger touches the pipe, the covering becomes damp around it, due to precipitation of moisture from the air, which, in time, is sure to ruin that section. When the piping is being put up before the covering can be applied, it is always best to put the hanger around a block of wood of the same thick-

ness as the covering and remove the wood as the pipes are covered.

Cork covering for brine and ammonia headers is made from one to four inches in thickness and coated inside and out with a mineral rubber finish. The 4-inch thickness is used in low temperature brine lines to freezers and the two and three-inch thickness for ammonia gas and brine pipes, in ordinary cold storage work (Fig. 119).

The covering is put on with waterproof cement between the joints and wound every two feet with soft copper wire.

Hair-felt insulation is frequently used and will give satisfaction when properly applied.

Two or three layers of one inch thickness are wrapped around the pipe after this has been coated with hot asphalt

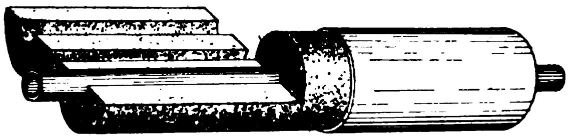


FIG. 119—CORK COVERING FOR PIPES.

or pitch and each layer is separately wired with drawn copper wire and covered with waterproof paper.

The outside layer should be finished with a canvas cover, laid spirally and coated with an elastic waterproof paint.

In Figure 120 is illustrated the insulating of refrigerating pipes laid underground.

The trench is excavated to the required depth and half of a split drain tile laid on the ground and filled with a mixture of granulated cork and hot asphalt. The pipes are then laid in the tile and covered over with the same mixture before the top cover is put on.

All joints must be carefully sealed with Portland cement mortar and made watertight.

The tile should be vitrified, salt-glazed, sewer tile and large enough to allow for a four-inch covering all around the pipe.

Where the underground mains carry brine at a very low temperature, it is better to use the compressed instead of the granulated cork covering, in order to reduce the size of the tile.

The same method of insulation can be used and a 2-inch plank-box substituted for the tile. The wood should be coated with creosote or other wood preservative and lined inside with waterproof paper, where the work is of a permanent nature.

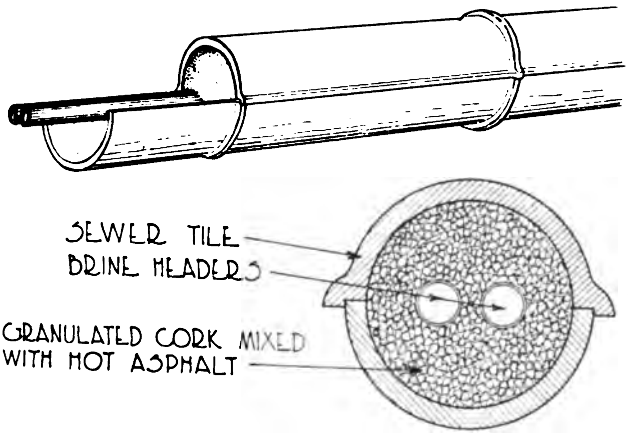


FIG. 120—METHOD OF INSULATING PIPE UNDERGROUND.

Lumber in the Insulation

Where the building is of fireproof construction, lumber is not needed as a part of the insulation, except in temporary work.

It is principally in packing house coolers and in mill constructed cold storage buildings that wood is used, to any extent, in the insulation, either as support for other insulating materials or as an outside finish.

All wood is not equally well suited to cold storage use and preference should be given to lumber cut from wood which is practically odorless, such as white pine, spruce or hemlock.

Yellow pine contains too much pitch to be used in cold storage rooms, since the odor would taint many of the goods held in storage.

All exposed woodwork should be painted or varnished to keep it odorless. If the wood is left in its natural state it readily absorbs the odors of the room which would be detrimental to many products, such as milk, cream, butter and eggs.

Painting also prevents the wood from swelling or shrinking when there is a change in the hydrometric state of the atmosphere in the room.

Swelling of the wood should be guarded against, particularly in packing house coolers and pipe lofts, where there is a great deal of moisture in the air.

The lumber used in the construction of air ducts and partitions is brought to the building in a kiln-dried state and put up with close joints and frequently left unpainted. Partitions erected in this manner will swell out of shape as soon as the coolers are in use and invariably have to be taken down and rebuilt. Two coats of paint or varnish would have protected the wood from moisture and greatly improved the appearance as well as prolonging the life of the woodwork.

Lumber cut from yellow pine and Oregon fir is more durable than the softer and less resinous woods, and can, therefore, be used to better advantage in places where there would be no objection to the resinous odor of the wood, as, for example, ice storage rooms, pickle cellars and covering for ice tank insulation.

The woodwork should be finished in varnish on hard oil, as it contains too much pitch to take paint well.

Insulating Paper

Paper is used in insulation work to prevent the passage of air and moisture through the cracks and joints in the insulation. It is only employed where these defects are not sealed by other means, such as asphalt paint or cement binder.

Only waterproof paper, which is especially made for insulating purposes, should be used. The standard brands are all put up in rolls 36 inches wide, containing either 500 or 1000 square feet.

Tarred or saturated papers are not suited for cold storage, as they emit a strong odor which will taint the goods in storage.

The paper should be applied in as long lengths as it is convenient to put up and the joints should be lapped at least two inches and sealed with hot asphalt.

When the paper is torn by careless handling it should be replaced or another layer applied over the damaged part.

Plastering on Insulation

The exposed surfaces of the insulation should be plastered unless it is covered with tile or other sanitary finish.

Portland cement plaster is extensively used as a finish on account of its strength and great hardness. It is more resistant to moisture than ordinary lime cement, is quickly and easily mixed and the cost is reasonable.

Mixing

The mortar is made of one part of Portland cement to two parts of sand and a bucket full of lime putty should be added to each barrel of cement.

The sand should be clean, sharp torpedo sand, screened and mixed in equal proportions with ordinary plastering sand. The mortar must be used immediately after it is mixed, as it sets quickly and cannot be retempered.

Applying

Two coats of plaster approximately one-half inch thick should be applied. The first coat is put on one-quarter inch thick, rough-scratched and left to set. After 24 hours, or before the scratch coat is dried out, the second coat. is applied and troweled to a smooth, even finish or floated to a sand finish, as may be desired.

Hair Cracks

The tendency of Portland cement to contract in the setting will cause the plastering to crack after it is finished.

To overcome this defect, the surface of the finish coat should be scored and divided into 4-foot squares. The plastering will then crack along the score-marks and these can be filled up with neat cement after the plastering is thoroughly dried out.

The scoring should be done with a straight edge after the plastering begins to harden and always the same day as the plastering is applied.

Asbestos Fibers in Plastering

Scoring of the plastering is frequently objected to on account of the checker-board appearance of walls and ceiling. The plastering can be prevented from cracking by adding asbestos fiber to the mortar in the same manner as cattle hair is added to ordinary lime plaster.

The author has used the following mixture for two-coat work with very satisfactory results: Two cubic feet of Portland cement to four cubic feet of sand and two shovels full of asbestos fiber. To this is added one-half bucket of slaked lime.

The asbestos fiber will tend to lighten the color of the plastering so that it appears as a medium grey instead of the very dark grey color of the ordinary Portland cement plaster.

Keene's White Cement Finish

White cement and white sand should be used where a better grade of finish is desired. There are many excellent makes of white Portland cement on the market, but none has given as good results in cold storage work as the imported Keene's cement. This cement is a plaster imported from England and produced by recalcining plaster of paris after soaking it in a saturated solution of alum.

This material is very hard and can be troweled to a highly polished surface. It is extensively used in wholesale markets, sales coolers and places where a white, sanitary finish is desired, without resorting to enameled paints or tile. It will not disintegrate in moist rooms and will remain white in color. It is applied as a skim coat over two coats of Portland cement mortar. The second coat is troweled

to an even, uniform surface, and keyed for the finish coat. This is applied very thin and carefully worked with a steel trowel as soon as the cement begins to set. It can be polished afterwards with a felt rag and made to look like artificial marble.

The finish is mixed in the proportion of five parts of Keene's cement to one part of white sand or marble dust.

Lath

Metal lath is used to stiffen insulated partitions built of cork board. The lath should be galvanized and securely fastened to the cork with galvanized staples, driven about five inches apart.

Only lath which is stiff and rigid should be used, and for that reason expanded metal lath is extensively employed. This lath does not require stretching and can be fastened directly to the partition. The standard sheets are 18 inches wide and eight feet long and the size of the mesh is 3/16x1¼ inches and ¼x1¼ inches. The former is best adapted for cement plaster.

CHAPTER XVI

REFRIGERATION

Introduction

The science of refrigeration is too broad and comprehensive, both in its theoretical and practical aspects, to be given more than a short resumé, in a book of this character.

There are many excellent text-books available for those who wish to give the subject a careful study.

This chapter will be devoted to a brief description of the two types of refrigerating machines, which are in common use in packing houses and cold storage plants. A few practical rules will be given regarding the amount of refrigeration and piping required in this class of buildings.

The selection of the refrigerating machine best adapted to the conditions under which it is to operate, and the work to be done by the machine, are matters that should be carefully considered.

All commercially practical refrigerating machines are merely devices for reclaiming the liquid chemical, which has been evaporated to a gas in the cooling chamber.

Anhydrous ammonia is one of the principal refrigerants, and for purposes of economy must be changed back to a liquid state, in order that it may again and again be evaporated, and in so doing, continuously extract heat from the body to be cooled. Therefore, a machine which economically gathers the spent gas from the refrigerating chamber, and reduces it to a condition where it can be used again, is a practical refrigerating machine.

There are two principal types of ammonia cooling machines in use today producing refrigeration for commercial purposes. They are known as the ammonia absorption and the ammonia compression systems, the names being

derived from the method of operation peculiar to each type.

To comprehend how refrigeration is actually obtained by either system, it is necessary to know something of the characteristics of ammonia. If pure anhydrous ammonia liquid at, say 75° F., and at 127 pounds gauge pressure, be drawn out into an open vessel, it will boil and evaporate very rapidly until the temperature of the liquid ammonia is reduced to about 28° below zero. This means that at atmospheric pressure, the boiling temperature of ammonia is more than 100° below the normal summer temperature. The boiling away, at first, is very violent, until the evaporation cools the liquid itself; any subsequent boiling is caused by heat from adjacent sources. Had the ammonia liquid been evaporated in a closed vessel at 15 pounds gauge pressure, the same result would have been obtained, except that the evaporation of the liquid would have reduced its temperature only to zero degrees Fahr. and the resultant gas would have twice the weight per cubic foot of the gas evaporated at atmospheric pressure. On the other hand, had the ammonia liquid been evaporated in a vessel under a partial vacuum, the boiling point would have been lower and the resultant gas lighter per cubic foot.

So far, we have considered refrigeration, in degree only, by the evaporation of ammonia. Let us now consider refrigeration by the volume and make some comparisons.

Almost any volatile liquid may be used as a refrigerant. Water, though it boils, in open vessels, at 212° Fahr. ordinarily, will, if subjected to a vacuum of 29″, boil violently away about one-third of its volume and the balance will freeze to ice. Most people have experienced the cooling effect produced by evaporating from the hand, high-test gasoline or grain alcohol, which is mild refrigeration on a very small scale. More heat is required to change the temperature of water, through a determined range of temperature, than other liquids commonly known. Therefore, the heat-energy required to raise or lower a pound of water one degree Fahr. at its maximum density, is used as a standard and is known as one British Thermal Unit. To change a

pound of water at 212° F., in an open vessel, to a pound of steam at 212° F. requires 970.4 B. T. U. To freeze a pound of water at 32° F. to a pound of ice at 32° requires approximately 144 B. T. U.

Water is plentiful in all localities, but it is not a desirable medium of refrigeration. While it requires approximately 1000 B. T. U. to evaporate a pound of water to a pound of vapor, it only requires 144 B. T. U. to change a pound of water to a pound of ice. Other objections are, the low evaporating pressure required to reduce its temperature and the further fact that it freezes at 32° Fahr., eliminates water as a desirable refrigerant.

Ammonia, on the other hand, is a most satisfactory refrigerant. At fifteen pounds pressure, it evaporates at a temperature low enough for most commercial purposes and every pound of liquid at 75° F., evaporated to a gas at 15 pounds gauge pressure, takes 480 B. T. U. net from the refrigerated chamber.

All cooling machines are rated in tons of refrigerating effect, based on a 24-hour day. Therefore, a one-ton refrigerating machine should be able to perform the same service in removing heat, in a day of 24 hours, as would one ton of ice, if completely melted in that time.

If to freeze one pound of water requires 144 B. T. U., a ton will require 2000 $\times$ 144 B. T. U., or 288,000 B. T. U., or at the rate of 12,000 B. T. U. per hour and 200 B. T. U. per minute. For example, if one pound of pure ammonia evaporated requires net 480 B. T. U., and 12,000 B. T. U. per hour equals refrigeration at the rate of one ton per day, then $\frac{12{,}000}{480} = 25$ pounds of pure ammonia must be handled by the refrigerating machine per hour.

Compression Machines

The compression machine depends almost entirely on mechanical energy to reclaim spent gas. As the name implies, the compression system employs a compressor, which is merely a well-designed device for pumping a gas and compressing it to a higher pressure.

Refrigeration is a relative term for temperatures below normal and is usually considered as the production of cold. Actually it is the extraction of heat from the body to be refrigerated. To secure low temperatures, low evaporating pressures in the ammonia chamber must be maintained. The compressor pump must carry away from the expansion chamber, ammonia gas as rapidly as it is formed, in order to maintain the necessary low pressure and secure the desired refrigerating temperature. To return the spent gas to a liquid state, the ammonia gas pump compresses the gas to a much higher pressure, changing some of the latent to sensible heat. The hot ammonia gas is then delivered to a purifying device, usually an oil separator, to remove any traces of the oil which was used in the cylinder for lubrication. From the separator, the pure, dry ammonia gas passes into the condenser. The condenser is a closed vessel or system of pipe coils, arranged to be cooled by a continuous supply of fresh, cold water. The heat which the machine draws from the refrigerated body, together with the heat of compression, is transferred to the cold water on the condenser which leaves as hot water. The compressor, by delivering a steady flow of gas into the condenser, raises the pressure to a point where, under the combined influence of pressure and the temperature produced by the cooling water, the gas liquefies and is again ready to be conducted to the cold storage rooms or evaporating chamber and produce more refrigerating effect.

Experience has demonstrated that an ammonia gas compressor should have a pumping capacity of 7500 cubic inches displacement per minute for each rated ton of refrigerating capacity. These dimensions are based on drawing gas from the evaporating chamber at 15 pounds gauge pressure and delivering it at 170 pounds to the condenser. By varying these conditions, or the speed of the compressor pump, the capacity may be varied.

The power required to operate a compression machine and produce a ton of refrigerating effect will vary with the size, condition and design of the machine, from one and

one-third to two horsepower per ton of refrigerating capacity. It is evident that a compression refrigerating machine, to operate economically, should be an efficient gas pump. Since the rated refrigerating capacity of a compressor depends on pumping a specific volume of gas per minute of a definite weight and delivering it to the condenser, and the specific volume of gas at zero pressure is twice that at 15 pounds, it is evident that an ammonia compressor will have a 100 per cent more capacity pumping ammonia gas, evaporating at 15 pounds gauge pressure and zero degrees F. temperature, than it has at a gauge pressure of zero pounds and a temperature of 28° below zero.

Summing up the characteristics of the compression system, it is evident that it requires power to drive the gas-pump and a source of cooling water for the condenser. On account of the pressure of the gas to be handled, there are heavy reciprocating parts, flywheels, etc., which require quite extensive foundations.

The conditions favoring a compression refrigerating machine, then, are, a cheap source of power, high refrigerating temperature, a supply of cooling water, and an ample, suitable space for the equipment.

Absorption Machines

The foregoing description of the characteristics of water, ammonia, etc., will assist in describing the action of the absorption system for producing refrigeration.

For comparison, it should be noted that the compression machine received the low pressure ammonia gas from the evaporating chamber, compressed it mechanically to a high pressure, and delivered it directly to the condenser.

The absorption machine has a very different plan of operation. In order to comprehend fully how the results are obtained, the fundamentals must be understood. As stated, the water in an open vessel boils at 212° F. and weighs about 62 pounds per cubic foot. Under the same conditions, pure ammonia boils at 28° below zero and weighs about 40 pounds per cubic foot. It is a known fact that ammonia gas discharged into cold water is condensed

and absorbed into the water quite as readily as a jet of steam discharged into cold water is absorbed, and the heat of the steam is conveyed into the water. It becomes evident that, if a quantity of ammonia gas is absorbed into water, in an open vessel, the resultant liquid, called aqua ammonia, absorbs the heat given up by the gas. The aqua ammonia will have a boiling point somewhere between 212° F. above and 28° F. below zero. Also it will weigh per cubic foot less than pure water and more than pure ammonia liquid. A cubic foot of water at a temperature of 50° F. will absorb 900 cubic feet of ammonia gas and at 32° F. will absorb approximately 1100 cubic feet of gas. If the gas is mixed with the water under a greater pressure, the volume possible to be absorbed will be greater.

With the foregoing facts established, they are applied in practical operation as follows: The absorption machine is provided with a closed vessel, or a series of them, called an absorber, into which the low pressure gas from the ammonia evaporating chamber or cold storage rooms is conducted. Into this vessel there is also conducted a continuous supply of weak aqua ammonia, usually in the form of a spray. This spray comes in intimate contact with the ammonia gas, which is immediately condensed and absorbed, and falls to the bottom of the absorber as strong aqua ammonia. The heat in the gas which is brought from the refrigerator is conveyed to the resultant liquid. This absorber, from which the system gets its name, may be compared to the suction stroke of the compressor, since it pulls the gas from the evaporating chamber. The next step is to separate the gas from the water and deliver it economically to the condenser. As previously stated, the ammonia absorbing capacity of water depends upon the temperature of the water and the pressure of the gas. To increase the efficiency of the absorber, it is necessary to make the weak aqua ammonia, entering the absorber, as cold as possible, in order to increase its holding capacity. Then to drive off the ammonia gas we need only to reverse the absorption process and heat the strong aqua ammonia.

The absorption machine is provided with an apparatus to accomplish this purpose, which is called a generator. It consists of a closed vessel, in the lower portion of which is located steam-heating coils. To transfer the strong aqua ammonia to the generator, a small pump is employed. Since the low pressure gas from the refrigerating chamber has been condensed to liquid form, its volume has been greatly reduced and the absorption ammonia pump need only have one-fiftieth the cylinder displacement, required by the gas pump of a compression machine of the same refrigerating capacity.

The absorption pump is usually automatically operated by a float resting in the strong aqua ammonia liquid. When the liquid rises to a fixed point the float rises and starts the pump. It draws the liquid from the absorber and delivers it through a heater, called an exchanger, to the generator. The strong liquid comes in contact with the generator steam coil and is heated. The ammonia, having a lower boiling point than the water, is driven off; the hotter the temperature, the weaker, in ammonia, the remaining solution becomes. The gas, leaving the generator, is conducted to a purifier, usually called a rectifier, to remove any traces of water, which is the only impurity it would contain, and from here it is delivered to the condenser. The condenser of the absorption system may be identical with the same part in a compression system. Here the ammonia gas, under the combined influence of the pressure developed in the generator, by driving off the gas and the cool surfaces maintained by the water, condenses to a liquid and is at once ready to perform refrigerating effect again.

It was stated that the absorber compares favorably with the suction stroke of the compressor pump; the ammonia generator of the absorption system has a like relation to the discharge stroke of the compressor.

To increase the operating economy and efficiency of the absorption machine various devices have been added to the described parts; principal among these is the ex-

changer. This is a device through which two streams of liquid can pass in opposite directions, through separate channels, yet be in thermal contact. It is placed between the absorber and the generator on the discharge side of the ammonia pump. The hot, weak aqua ammonia, from around the generator steam coils, is allowed to pass out of the bottom of the generator on its way to the absorber for a fresh charge of gas.

Since the absorbing capacity of the weak aqua ammonia is increased by being cooled, it may first pass through the exchanger, where it passes the cold, strong aqua ammonia from the absorber and is cooled thereby.

After leaving the exchanger, it may be passed through a coil cooled with water, to further reduce the temperature. This part is called a weak liquor cooler. The strong, cool aqua ammonia, from the absorber on its way to the generator, must be heated to drive out the gas picked up in the absorber. Therefore, these two liquids are made to pass through the exchanger in opposite directions, one being heated and the other cooled.

The absorption system in reclaiming the spent gases first liquefies the gas by mixing it with a small volume of water, which same water is used over and over again continuously. In this convenient form, it is pumped into the generator or still, which is usually heated by the exhaust steam from the machine auxiliaries at low pressure. Here the heat drives off the working charge of ammonia and the water is promptly returned to the absorber for a fresh charge. Note that the water in the ammonia chamber is used as a liquid conveyor and for no other purpose and has no connection with the cooling water that circulates through the machine and carries away the heat extracted from the refrigerated body.

Referring to the compression system, it was made evident that when the ammonia evaporated at zero gauge pressure, the compressor was able to do less than half the work it could do if the evaporating pressure was 15 pounds gauge. This falling off in capacity is not found in the ab-

sorption system, under similar conditions. An absorption machine capable of producing 100 tons with the ammonia evaporating pressure of 15 pounds would lose only about six per cent of its rated capacity if the pressure of the spent gas were zero pounds gauge. The absorption system has what is called a flat characteristic load capacity. The amount of ammonia gas it will handle is not based on a fixed cylinder displacement, as is the case with a compressor, but causes a steady pull by the affinity for gas of the weak aqua in the absorber.

The absorption machine is especially adapted to produce refrigeration economically where there is available a uniform supply of exhaust steam. Since this is the principal agent required, it is a large factor in reducing the cost of operation. From 30 to 40 pounds of exhaust steam per hour is required in the generating coils per ton of refrigerating effect; the amount will depend largely upon the brine temperatures to be maintained as well as the temperature of the cooling water. Cold condensing water is desirable, but where not obtainable the machine should be built to suit operating conditions. Warm condensing water requires more volume and increases the power required for a compressor, and higher steam temperature in the generator of the absorption machine.

The power required to operate the ammonia liquor pump of the absorption system, which is the only moving part, may be either steam or mechanical power and will not exceed one horsepower for each 15 tons of refrigerating effect produced. Having no heavy high tension reciprocating parts, it may be located in any convenient place and in the foundation design the dead weight of the pump only need be considered.

Refrigeration in Packing Houses

The capacity of the refrigerating machine required to properly cool the cold storage rooms in a packing plant will depend upon the following conditions: (1) The quality of the insulation, (2) the size of the rooms, (3) the tempera-

ture of the rooms, (4) the amount of warm meat which is put in storage.

The following rules are derived as the result of practical experience and are based on general practice now in use. They can be verified by calculations which, in all cases, will be found to require less refrigeration than herein stated. In actual operation, however, it is always the most severe conditions and the maximum requirements in the plant which must be provided for. This may give a reserve capacity for a greater part of the time, but it will also assure the owner that when all the capacity is required at one time it will be available, both in the engine room and in the cooling pipes. Safety first is a good rule to follow in laying out refrigerating work, and seems to be generally practiced by refrigerating engineers.

Practical experience is the guide usually followed in computing the size of the machine. The prevailing practice is to install a machine which will handle the output of the plant when this is run at its maximum capacity, and to provide also a smaller reserve machine, to be operated when less refrigeration is required.

The space which can be cooled in 24 hours by one ton of refrigeration is generally figured between 5000 and 12,000 cubic feet, depending upon the temperatures to be carried.

Freezer storage at 15° Fahr. is figured at 5000 cubic feet per ton and curing cellars at from 10,000 to 12,000 cubic feet per ton.

Packing house coolers are nearly always of large size, so that the opening of doors and the number of electric lights, men working in the cooler, etc., are a less important factor than in small rooms, where these facts must be taken into consideration and cooling pipes provided accordingly.

The refrigeration required for beef and hog coolers must be figured by the number of animals which are killed daily.

The usual practice in well insulated colers is to allow

one ton of refrigeration per 24 hours for the following number of freshly killed carcasses:

5 to 6	Cattle	average weight	700 lbs.
15 to 22	Hogs	average weight	225 lbs.
50 to 65	Sheep	average weight	60 lbs.
40 to 50	Calves	average weight	80 lbs.

The following test was made in a Chicago packing plant, and gives some interesting and accurate data on the actual requirements of refrigeration as well as the cost of cooling:

TOTAL COST OF REFRIGERATION PER 100 CARCASSES

Carcasses	Tons Refrig.	No. Ccs. per ton	Total Cost per 100 Ccs.
100 Cattle	19.60	5.1	$9.85
100 Calves	2.65	37.7	1.32
100 Sheep	2.48	40.3	1.19
100 Hogs	6.50	15.4	3.24
100 Shippers	2.80	35.7	1.38

Refrigerating Pipes in Packing House Coolers

The amount of cooling surface which is required in the piping of a room to maintain the desired temperature depends upon the quality of the insulation, the size of the room and the temperature of the brine or the ammonia gas.

In warm beef and hog coolers, the method of regulating the temperature will influence the amount of refrigerating pipes which will be required. In these coolers it is necessary to remove the animal heat without chilling the meat too rapidly or permitting the air in the room to rise above a certain temperature. This will, therefore, require a larger amount of piping than is later needed to maintain the temperatures after the animal heat is removed. The chilling process must be graduated so as to slowly bring the meat down to the temperature at which it is to be kept in storage. This requires a system of coils, arranged so that the refrigeration can be turned on in part or all at once, according to the needs.

The usual packing house practice in well insulated coolers is to provide the following amount of direct expansion piping. The table is based upon one lineal foot of

2-inch pipe for the stated number of cubic feet, and this must include the cooler as well as the pipe-loft above.

Warm Beef Cooler......	1 lineal foot per 10	cubic feet
Beef Storage Cooler.....	1 lineal foot per 12	cubic feet
Sheep Coolers	1 lineal foot per 12	cubic feet
Hog Coolers	1 lineal foot per 8	cubic feet
Sausage Cooler 30°F. ..	1 lineal foot per 10	cubic feet
Curing Cellars 36°F. ...	1 lineal foot per 18	cubic feet
Freezers 15°F.	1 lineal foot per 6	cubic feet
Freezers 0°F.	1 lineal foot per 2½	cubic feet

This amount of piping is ample to properly maintain temperatures when the pipes are reasonably free from frost.

Details of Supports for Refrigerating Pipes

The method of supporting the pipes in cold storage rooms is different on almost every job. This is caused

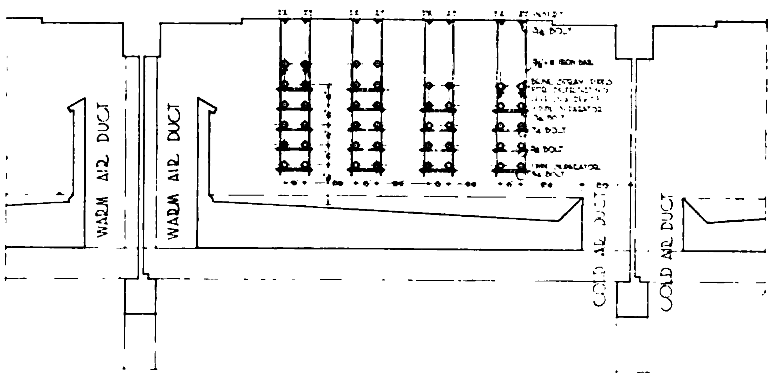


FIG. 121—ARRANGEMENT OF PIPES OVER BEEF COOLER.

either by difference in building construction or by the preference of the contractor for a special style of support. When the erection of the refrigerating pipes is contracted for, and no particular type of hanger is specified, it is left to the discretion of the contractor what constitutes a substantial, serviceable hanger. This may not always be satisfactory, since it gives the contractor an opportunity to put in something "just as good."

In fireproof buildings, with the best of equipment, the life of the hanger should, at least, be equal to that of the piping, and they should be of rigid construction and sub-

stantially put up, so as to carry the weight of the piping when this is covered with ice. In pipe lofts, where a defrosting system is used, the hangers should be galvanized by the hot process, so as to withstand the action of the salt brine. In buildings of wood construction the hangers should be bolted to the ceiling and not fastened by lag screws, which is the method generally used by contractors. Inserts should be used in concrete ceilings instead of bolts, so that the supports can be renewed, if they rust out.

The following illustration shows methods of supporting the pipes under various conditions.

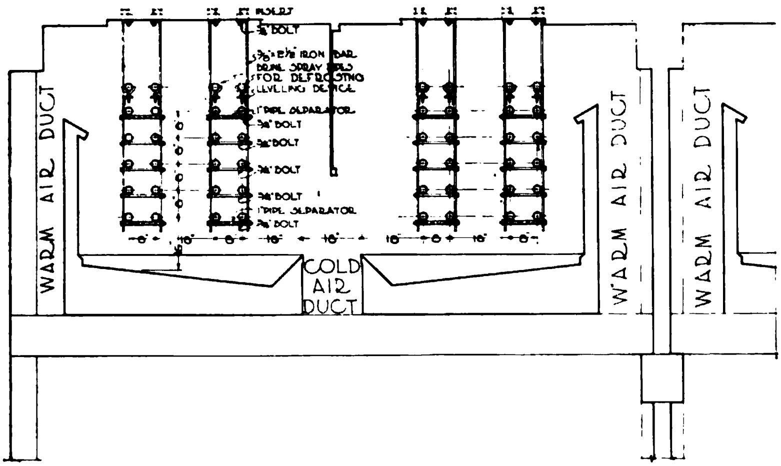


FIG. 122—ARRANGEMENT OF PIPES OVER HOG COOLER.

In Figures 121 and 122 is illustrated the piping in beef and hog coolers. The hangers are supported from the ceiling above and bolted to the inserts, which are built into the concrete. The advantage of this construction over any method which supports the pipes from below is evident. The piping is not affected by the vibration of the timber construction in the cooler, due to beef and hogs being pushed along the rails. It also leaves the drip-pan free of any obstructions which may interfere with the proper drainage.

The hangers are made from $\frac{3}{8}$x2$\frac{1}{2}$-inch iron and the pipes rest on $\frac{3}{4}$-inch bolts. The top and bottom bolts are run through 1-inch pipe separators, which prevent the hangers from being squeezed together.

The supports for the brine defrosting pipes are adjustable, so that the pipes can be raised or lowered as needed to distribute the brine evenly over the entire length of the coil.

The hangers should always be placed so that there will be room between each two rows of pipe for making any necessary repairs.

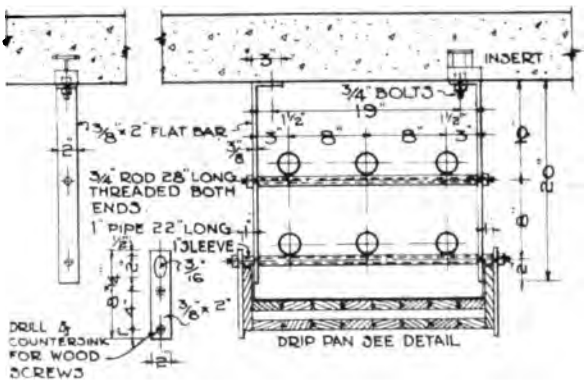


FIG. 123—DETAIL OF HANGER FOR CEILING COIL.

In Figure 123 is illustrated a method of supporting a pipe coil from the ceiling in cold storage rooms.

The hangers are made of $\frac{3}{8}$x2-inch iron and are bolted to the inserts. The pipes are carried on $\frac{3}{4}$-inch rods with 1-inch pipe separators to keep the hangers apart. The lower support is extended beyond the hangers and carries the drip-pan below the coil. The pan is made of two thicknesses of $\frac{7}{8}$x6-inch dressed and matched boards, with a 1-inch air space between, and is lined with prepared roofing.

In Figure 124 is illustrated a hanger for supporting the piping along a wall. It is made of $\frac{3}{8}$x2$\frac{1}{2}$-inch iron and the

pipes are carried on $\frac{3}{8}$x2-inch bearings, which are riveted to the hanger.

In Figure 125 is illustrated a support for a pipe coil in

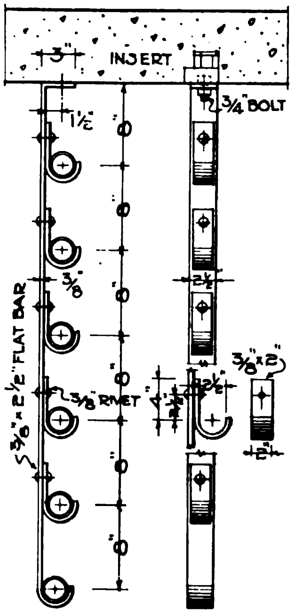


FIG. 124—DETAIL OF HANGER FOR WALL PIPES.

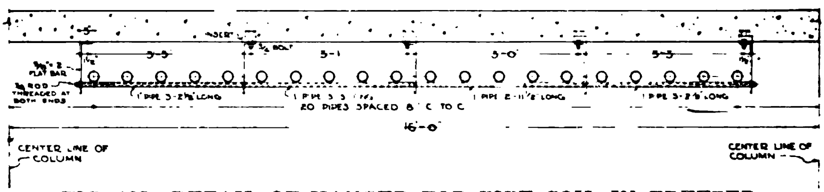


FIG. 125—DETAIL OF HANGER FOR PIPE COIL IN FREEZER.

the ceiling of a freezer room. The hangers are placed about three feet apart and bolted to inserts with $\frac{3}{4}$-inch bolts. The pipes rest on 1-inch pipe separators and the load is carried by a $\frac{3}{4}$-inch rod which is continuous from end to

end. The rod cannot be removed except by unscrewing the nuts at each end.

In Figure 126 is illustrated a pipe rack used in the sharp freezers, where the goods to be frozen are placed directly on the cooling pipes. These racks are much used in packing houses and in fish freezers and are arranged so that goods can be handled from both sides of the racks. The pipes are supported by 3-inch channel irons riveted to 4-inch channel iron uprights which are fastened to the floor and ceiling. The unevenness of the concrete makes it impossible to cut the uprights to the exact lengths required and have them fit correctly in all parts of the job. They should, therefore, be made ½ inch shorter than the distance between the floor and the ceiling and should be provided with an adjustable attachment at the top which will permit of a slight variation in the construction. The detail shows a 2-inch bar bolted to the top of the channel iron. The bar extends up into the concrete ceiling and is made adjustable on the channel iron by a slot cut in the bar.

Defrosting of Refrigerating Pipes

When the air in the room is prevented from coming in direct contact with the refrigerating pipes, due to heavy frost on the pipes, there is a reduced efficiency in the cooling system. For this reason, the pipes are regularly scraped free from frost, in plants where the cold storage rooms are properly operated. To facilitate the removal of the ice after it is scraped off there should be provided means of fastening the drip-pans so that these can be unhooked on one side and the ice dropped on the floor.

In packing house coolers with overhead pipe lofts there should be installed a defrosting system, which will keep the pipes clean at all times.

This is very effectively accomplished by placing a perforated 2-inch brine pipe over each row of refrigerating pipes and let the brine trickle down over the cooling pipes. This arrangement is illustrated by Figure 127 and is also shown on the details of the piping in several other figures. The illustration requires a small open brine tank, about

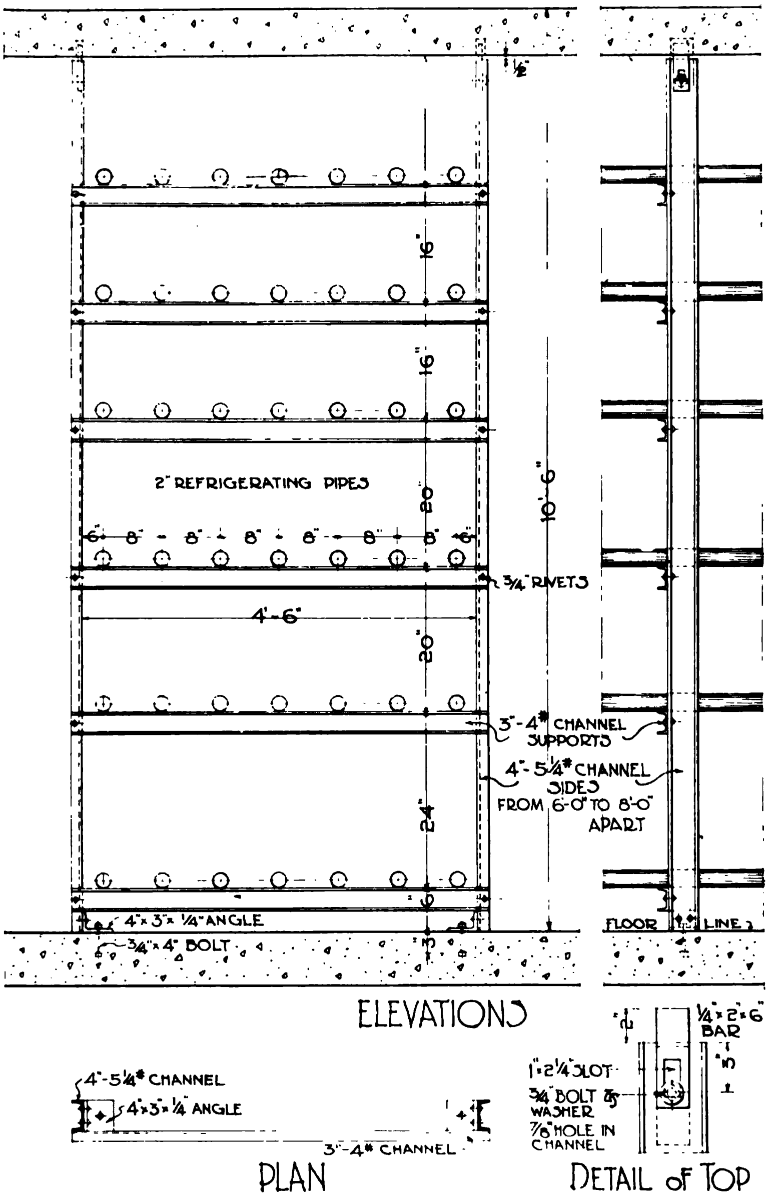


FIG. 126—DETAIL OF DOUBLE FREEZER RACK.

four feet in diameter and four feet high, which is placed either on the floor of the cooler or in some other convenient location. When the tank is not placed in a refrigerated room it will be necessary to insulate both the tank and the brine main.

A small centrifugal pump discharges the brine through the defrosting systems, and after it has passed over the cooling pipes it is collected on the floor of the pipe loft and returned by gravity to the tank.

The brine distributing header should be placed in the

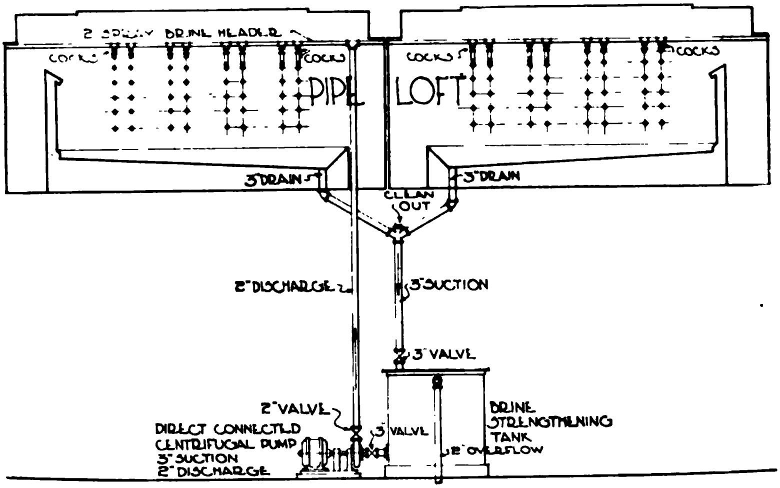


FIG. 127—DEFROSTING SYSTEM.

center of the pipe loft, in order to give an equal distribution of brine to the branch pipes on each side. These are controlled by shut-off cocks for turning on and off the brine as needed. The pipes are supported on adjustable hooks, so that they can be properly leveled and distribute the brine evenly over the entire length of the coil. The pipe is perforated on top with ¼-inch holes, spaced four inches apart, or it can be made so that the brine will flow out through a continuous slit in the top of the pipe. The header should be connected at each end to the return pipe in order to complete the circulation of the whole system.

CHAPTER XVII

COLD STORAGE DOORS

The demand for well constructed, air-tight cold storage doors, which will stand years of hard service, has placed the building of these doors in the hands of manufacturers who specialize in the construction of various cold storage equipment. There are a number of special cold storage doors on the market, which are built on the same general principle of construction, with the exception of some variations in the detail of jambs and casings. The manufacturers have patented the hardware they use, hence the expression "patented doors."

Construction

The ordinary type of patented cold storage door is made with an outside frame of 2-inch spruce lumber, beveled at the sides and cross-braced with 2x4-inch diagonal braces. This frame forms a hollow box four inches high, in which the insulating material is laid. The door is covered on both sides with two thicknesses of waterproof paper and finished with a paneled front and a tongued and grooved back of 7/8-inch lumber. It is further stiffened by extra hinge blocks and nailing strips, which gives a very rigid and strong construction throughout and prevents the door from sagging or getting out of shape.

The standard makes of doors, as furnished by the manufacturer, include the door-frame, casing on one side of the wall and all the necessary hardware. The door will be shipped crated and ready to be placed in the opening.

A common fault in many cold storage buildings is that the door openings are made too small. It should be remembered that when the door frame is placed in position the net opening is reduced from three and one-half to seven inches in width, depending upon the type of door used.

When there is much trucking through the opening this opening should be made wide enough to allow for ample clearance on both sides of the truck. A 5-foot 6-inch door is generally used in cold storage work, as it gives a net clearance of about five feet.

The standard doors, as made by the manufacturers, are not sufficiently protected against injury from trucks and packages passing through the doorway.

The author recommends that the corners of the door, as well as the jambs, be protected by 2-inch galvanized angle-irons and that the lower half be covered with No. 22 galvanized sheet iron. This protection must be specified when the doors are ordered, unless the purchaser intends to put it on after they are in place.

The specifications should also state that the doors must be covered with a coat of shellac as protection against moisture and consequent swelling while in transit.

Hardware

The preference given by many cold storage owners to one make of door over that of another is largely due to the hardware. The merits of any particular hinge or fastener can only be observed by continuous trial, in actual operation, and in comparison with other makes which have been similarly tested.

The hardware which is now used by all leading door makers has been perfected by them to such an extent that one marvels at the ease with which these heavy, clumsy doors are quickly opened and closed. It will keep the doors in perfect adjustment during years of hard service and is far superior to the old-fashioned strap-hinge and lever-fastener formerly used.

Galvanized hardware is furnished by the manufacturers when no particular finish is specified by the purchaser. They are prepared, however, to furnish any finish desired. Polished brass is often used in more pretentious places and looks well on oak-veneered doors.

High doors, eight feet or over, should be equipped with

three hinges and double fasteners, in order to prevent the top of the door from bowing away from the frame.

Insulation

The manufacturers will insulate the doors with any material specified by the purchaser, either hair-felt, mineral wool, lith, linofelt, granulated cork, or pure cork board will be furnished.

Since the efficiency of the door depends largely upon the durability and heat-resisting qualities of the insulation, preference should be given to doors insulated with the best materials. The author believes that cork board and granulated cork will give the best results.

The workmanship and labor necessary to manufacture the door is practically the same with any kind of insulating material. Therefore, the added cost of the door due to the use of a more expensive insulating material will be returned by the increased efficiency and life of the door.

Freezer doors should always be insulated with pure cork board set in hot asphalt. For ordinary cold storage doors granulated cork is generally used. This, however, like any other loose filler, has a tendency to settle after the door is in use, and leaves a void at the top of the door.

Installation of Doors

A common fault with cold storage doors is the manner in which they are installed. The manufacturer is seldom asked to send an experienced man to oversee the installation, consequently this is left to the building contractor or to the owner's employees, and unless they are familiar with the work there is trouble with the door, sooner or later.

The uprights to which the jambs are bolted must be strong and rigid and securely fastened to the building construction. The doors must be hung absolutely true and plumb, otherwise they will soon sag and work loose. The importance of having substantial support is evident when we consider that the weight of the ordinary cold storage door is about fifteen pounds per square foot.

The following illustrations of door installations show the type of door manufactured by a well known concern,

who make a specialty of this class of construction. This type was used only because it was necessary to depict a door.

In Figure 128 is illustrated a cold storage door, placed in a solid cork partition. The door frame is bolted to the

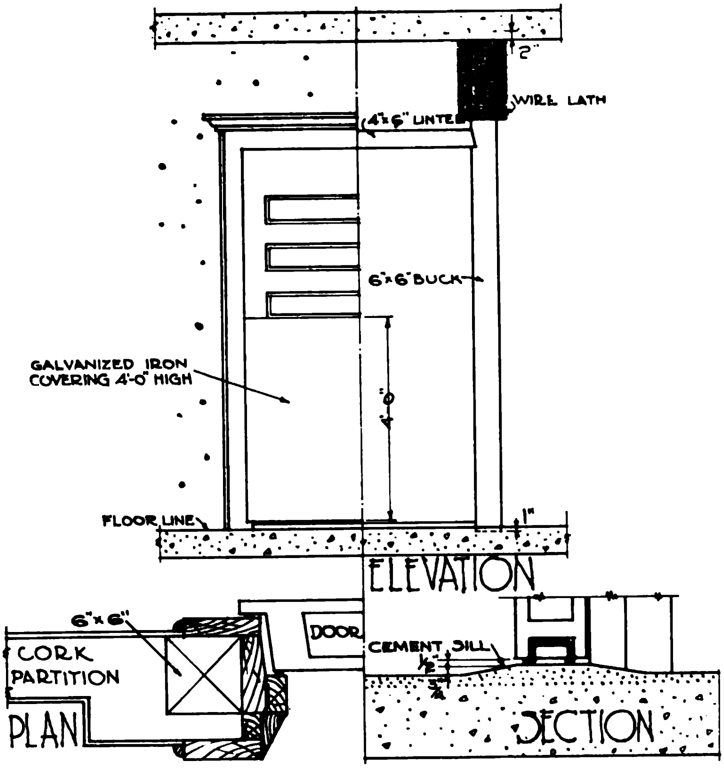


FIG. 128—REFRIGERATOR DOOR IN CORK BOARD PARTITION.

6x6-inch buck on each side of the opening and to the 4x6-inch wood lintel above the door. One-half-inch lag screws are used for bolting and they should not be placed further than 24 inches apart. The bucks are mortised into the concrete floor and ceiling and grouted with neat cement.

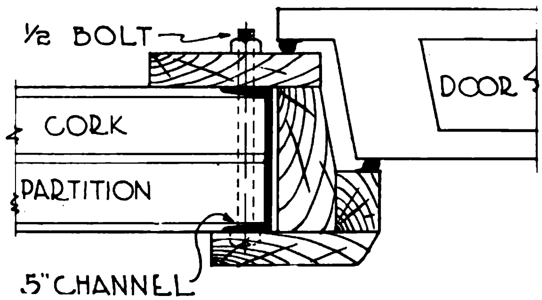


FIG. 129—REFRIGERATOR DOOR JAMB BOLTED TO CHANNEL IRON BUCKS.

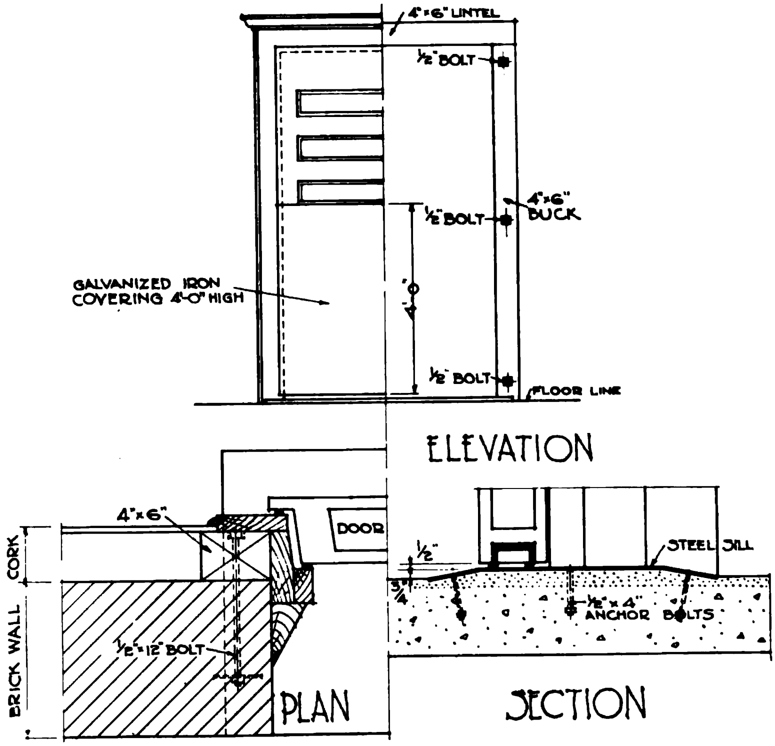


FIG. 130—REFRIGERATOR DOOR IN BRICK WALL.

Another method is to put up a channel iron buck fastened to the floor and ceiling and bolt the door jambs to the channel with ½-inch machine bolts every three feet (Fig. 129).

In Figure 130 is illustrated a method of fastening cooler doors, made for openings in brick walls. The 4x6-inch bucks are set flush with the inside face of the insulation and bolted with three ½x12-inch bolts. A 4x6-inch lintel is spiked to the top of the uprights and the door frame fastened at the sides and top with ½-inch lag screws.

In Figure 131 is illustrated a cooler door placed in a double brick wall where insulation is of the same type as that shown in Figure 88. The 6x6-inch bucks are set flush with the inside face of the 4-inch wall and bolted at the top and bottom to the steel lintel and sill. A 2½-inch angle-iron is fastened to the steel work and the bucks bolted to the angles with two ½-inch machine bolts.

The granulated cork insulation between the walls is held in place at the sides of the opening with a 3-inch plank sub-jamb, spiked to the bucks. The door frame is bolted with ½-inch lag screws, 24 inches apart. The space between the door frame and the supports should be caulked with oakum, driven in from both sides of the frame and the joints sealed with hot asphalt. When the joints are wider than one-fourth of an inch they should be filled with a mixture of cork dust and liquid asphalt, after being caulked.

Door Sills

Cooler doors should be hung so that the bottom of the door will swing clear of the floor. A raised door sill is, therefore, required for the door to close against. The sill should be beveled so as not to interfere with the trucking.

In concrete floors the sill can be formed by raising the floor at the opening, as shown in Figure 128.

A better job can be obtained by using a steel or cast-iron sill, anchored to the floor, as shown in Figure 130. Where wood floors are used, a beveled oak sill should be nailed to the underflooring. This sill should come as a part of the door frame and preferably made at the factory.

Doors With Overhead Track

When there is an overhead track or meat-rail passing through the door opening the door is made to swing below the rail and a small trap door is placed in the hood over

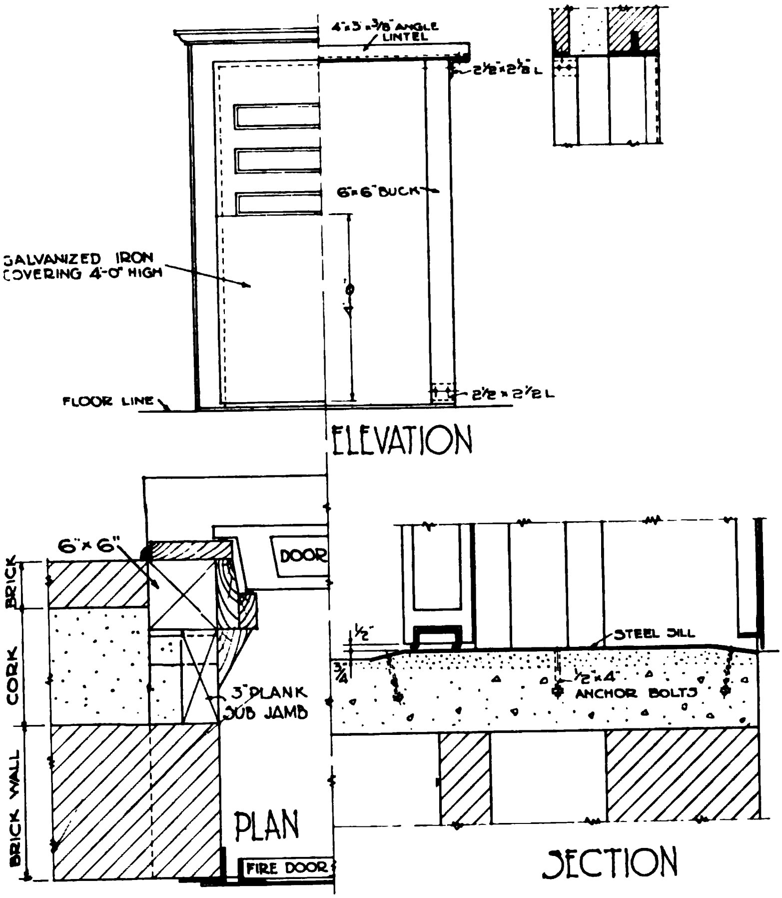


FIG. 131—REFRIGERATOR DOOR IN DOUBLE WALL INSULATION.

the door, covering the pocket for the rail. The trap is hinged at the top and controlled by a device which works automatically, opening and closing with the door.

A clearance of 10 inches is required from the underside of the rail to the lintel over the door.

How to Order Cold Storage Doors

Doors are made either "right hand" or "left hand," depending on which side of the frame they are to be hung. In order to tell which type of door is required, one should stand facing the door opening, so that the door opens toward him, and note on which side the hinges are to be fastened. If on the right, order a right-hand door; if on the left, order a left-hand door. This is illustrated by Figure 132.

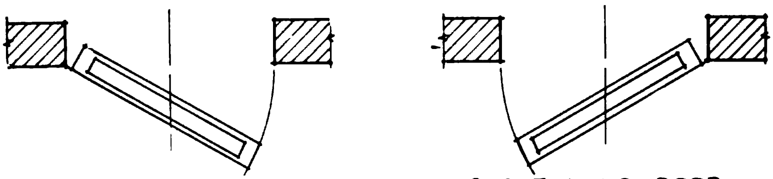


FIG. 132—METHOD OF DISTINGUISHING RIGHT AND LEFT HAND DOORS.

The manufacturer should be given full information regarding the type of insulation to be used in the door, also whether a cold storage or a freezer door is wanted. For track doors, give the exact height from the finished floor line to the underside of the rail.

The author recommends the following method of ordering doors where a variety of them is required for the building:

Size of Wall Opening		No. of Doors Required	How Hung	Track	Height to Under-side of Rail	Cold Storage Door	Freezer Door	Insulation	Sill	How Marked
Width	Height									
5′-0″	7′-10″	2	Left	Yes	7′-0″	Yes		Gran. Cork	Bev. Oak	14
5′-0″	6′-9″	1	Right	No			Yes	Cork Board	None	15

The above schedule, if carefully filled out, will simplify the ordering of doors and often avoid misunderstanding on the part of the manufacturer. If the number of the door is marked on the drawing as well as on the door it will materially assist the workmen in finding the correct door for any opening.

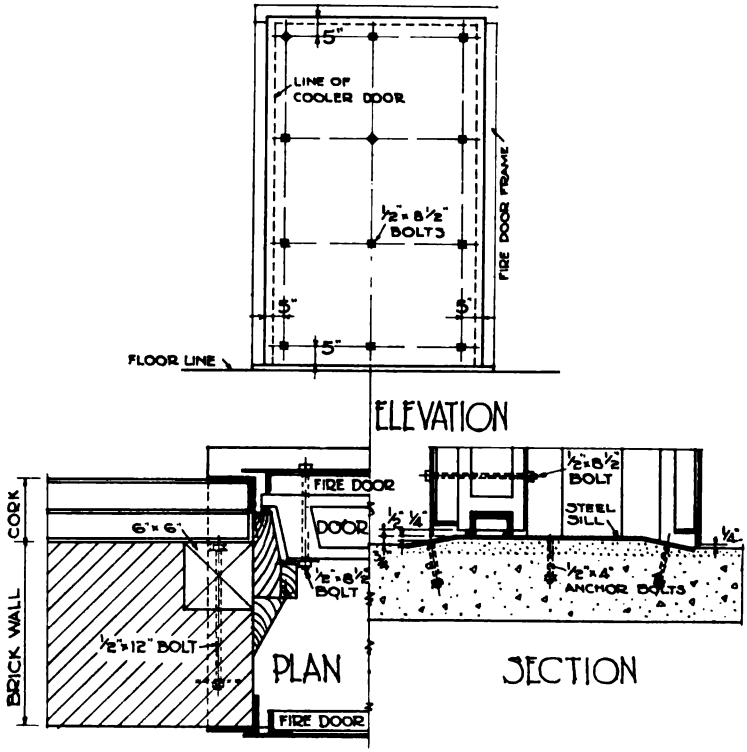


FIG. 133—REFRIGERATOR DOOR BOLTED TO STEEL FIRE DOOR.

The purchaser should clearly state the width and height of the rough opening in which the door is to be placed, bearing in mind that the net opening will be approximately six inches less in width and three inches less in height when the heavy door frame is in place.

Refrigerator Door Bolted to Fire Door

The combination of a refrigerator door and fire door is required for openings in brick walls where the underwriters do not permit the use of a tin-covered cold storage door. In order to open the two doors at one time it is necessary to bolt them together and hinge them from the fire door frame.

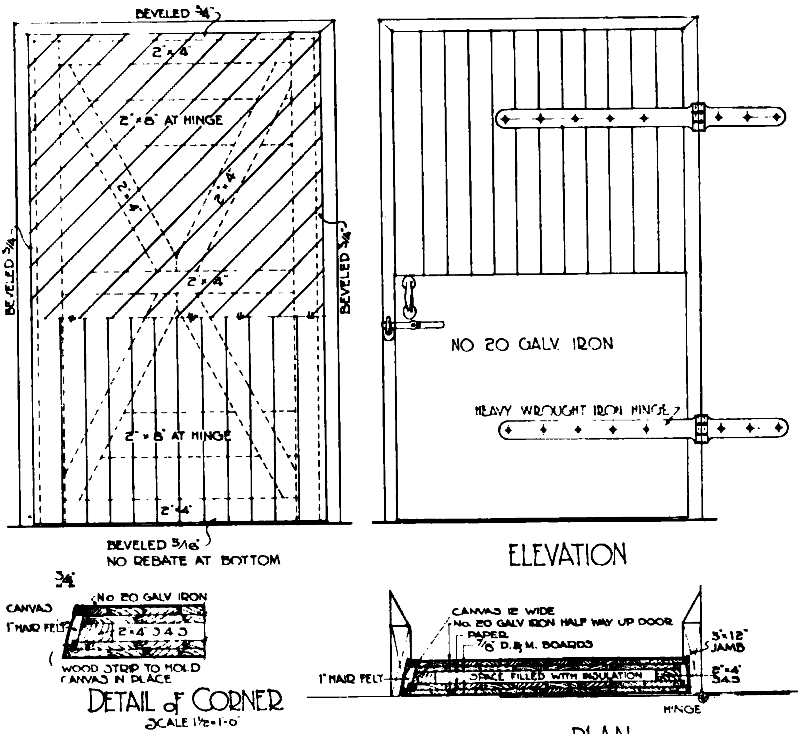


FIG. 134—DETAIL OF HOME MADE COOLER DOOR.

The hardware for the cold storage door is, therefore, omitted. The angle-iron frame is placed flush with the inside face of the insulation and tied to the frame on the other side of the brick wall.

In Figure 133 the doors are shown bolted with three

½-inch bolts at the top and bottom and with intermediate bolts on the side about 30 inches apart.

The holes in the fire door should be punched at the shop where the door is made and the cold storage door drilled and bolted on the job. The bolts by which the handles are fastened to the fire door must be long enough to pass through the refrigerator door, otherwise the doors could not be opened except from the inside of the room.

Home-Made Refrigerator Door

In Figure 134 is illustrated the construction of a cold storage door which can be made by the house carpenter or local mill. It is the type of door which was in common use before the "special door" was introduced. The frame and diagonal cross pieces are made of 2″x4″ lumber covered on both sides with insulating paper and two thicknesses of ⅞x6-inch dressed and matched boards. The first thickness of boards should be laid diagonally over the framework and covered with insulating paper. The outside boards are set vertically and extend one inch beyond the edges of the framework. This makes a rabbeted edge all around the door, which is filled with one-inch hair-felt and covered with heavy canvas cloth. The door is made with three-fourths of an inch bevel at the sides and top and the 3x12-inch jamb beveled to correspond. The hollow space formed by the frame and the stiffeners is filled with granulated cork or other insulating material. The lower half of the door should be covered on both sides with No. 20 gauge galvanized iron, if the opening is used as a passage for trucks. The hinges and fasteners should be of galvanized wrought iron and securely bolted through the door with galvanized iron bolts.

CHAPTER XVIII

COLD STORAGE WINDOWS

There is a wide difference of opinion regarding the value of windows in cold storage rooms. Many plants have been built without them, depending entirely upon artificial means for lighting and ventilation.

On the other hand, many modern plants have been designed with one or two windows in each room and without any other means of ventilation, depending upon the natural circulation of air which always takes place in large rooms with cooling pipes on the ceiling.

The windows can be opened when the temperature of the outside air permits if careful attention is paid to the temperature in the room while the windows are open.

It would seem that a limited amount of window openings in all cold storage buildings would be advantageous, for several reasons. First, as a means of access in case of fire and providing light if the lighting system be thus damaged. Second, as a means of ventilation during the season of the year when the outside air could be admitted without detriment to the goods in storage. Third, for ventilation of empty rooms during all seasons of the year. Fourth, for the purpose of providing natural light.

Windows should be located at the ends of trucking alleys, so that they can be opened without having to shift any of the commodities in storage. When they are opened for ventilation the air should be circulated by a portable fan, placed near the window. This greatly increases the circulation, and also overcomes the objection often expressed that windows will not ventilate sufficiently to be of any practical value.

Types of Windows

The usual type of window in cold storage buildings is made stationary and used only for the purpose of admitting natural light to the rooms. When both light and ventilation is desired, the windows must be made to open, and a hinged style is then used. The essential requirements of both types are that the joints be made tight and that there be sufficient glass with sealed air-spaces between to effectively reduce the transmission of heat through the glass.

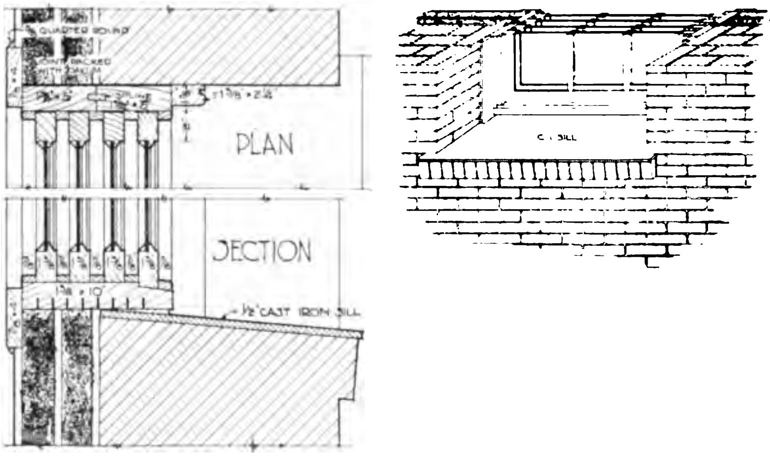


FIG. 135—DETAIL OF FIXED COLD STORAGE WINDOW.

When close attention is paid to the construction of the windows, and the insulation is carefully fitted all around the frames a satisfactory job can be made in cold storage work.

Windows in freezing rooms, however, should not be installed unless they are sealed on the inside with an insulated door-plug.

The efficiency of the window, from a cold storage standpoint, depends altogether upon the care with which it is made and put in place. The joints around the frame must be sealed with oakum and paint and the packing must form a continuous air-tight seal all around the sash.

The wood used in the construction of windows should be of clear white pine or cypress, as these woods do not crack or warp. The materials should be well seasoned, kiln-dried wood and the windows painted before being taken to the building.

Stationary Windows

These can be built as shown in Figure 135. The plank frame is made of $1\frac{3}{4}$x10-inch white pine, cut in two and splined. The four sash for the glass are made $1\frac{3}{8}$ inches thick and separated by $\frac{7}{8}$-inch parting strips. The casing is of $\frac{7}{8}$x4-inch yellow pine or other finishing wood and should not be put on until after the insulation is finished.

When the window is assembled the sash and parting strip should be set in white lead and oil paint and driven up tightly on all sides of the frame. The glass is tacked in place and bedded in felt which has been soaked in white lead and oil. The joints between the frame and the wall should be packed with oakum and sealed with asphalt pitch.

Hinged Windows

In Figure 136 is illustrated a type of hinged window which is made on the same principle as a refrigerator door.

The frame is beveled and rabeted for the sash, and anchored to the brick wall with two $\frac{1}{4}$x2-inch iron anchors on each side of the frame.

The large, heavy sash, which holds the four thicknesses of glass, is beveled on the sides and on top to correspond with the bevel on the frame. The sash should be made with two seals of contact with the frame when the window is closed, and the contact points covered with flexible rubber or felt packing, which is nailed to the sash. The glass is bedded in strips of heavy felt, soaked in white lead and oil paint. This makes an air-tight joint and prevents the glass from cracking, due to the swelling of the wood parting strips.

The sash should be hung with three hinges in order to prevent sagging. Two hinges are insufficient unless a patented spring hinge is used.

Fasteners should be put on at the top and bottom of the sash, when it is over four feet high. One fastener is sufficient for smaller sash.

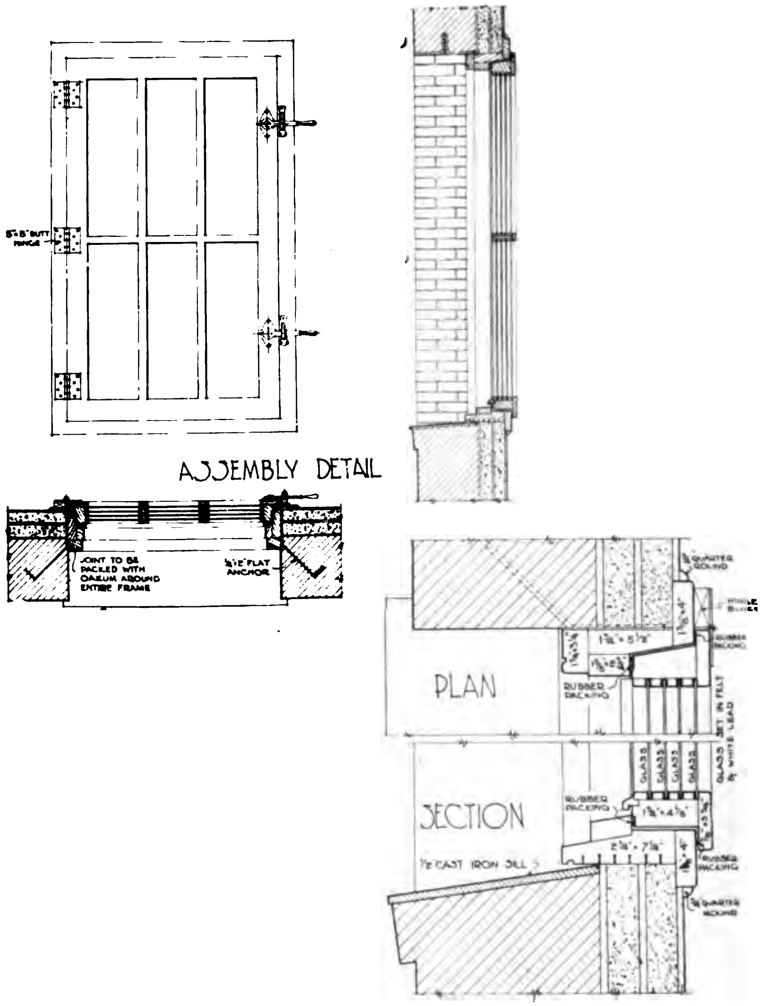


FIG. 136—DETAIL OF HINGED COLD STORAGE WINDOW.

Freezer Windows

In Figure 137 is illustrated a false window which can be used in freezer rooms, where it is desirable to provide outside ventilation. The opening in the wall is closed by a hinged door plug, which is insulated and has a glazed sash on the outside. The sash is put on for appearance sake and can be omitted where there is no object in having the imitation window.

The door plug is insulated with four inches of cork board covered on both sides with paper and 7/8-inch dressed and matched V groove boards, set vertically.

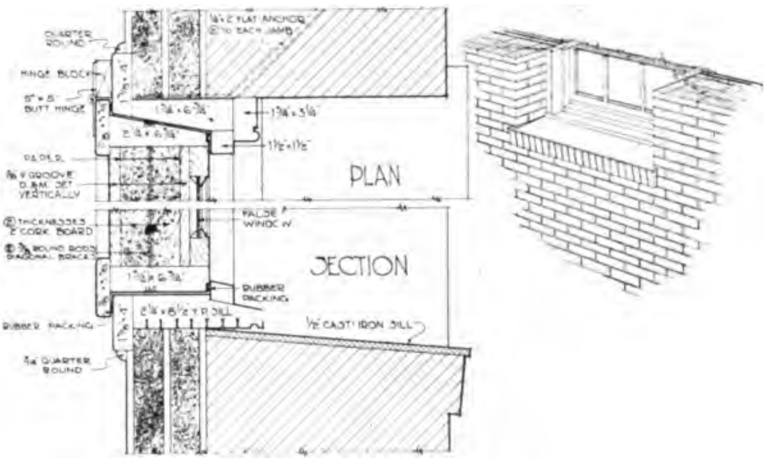


FIG. 137—DETAIL OF HINGED FREEZER WINDOW.

The door and frame is beveled on the sides and top and the two seals of contact between door and frame are covered with a flexible packing of rubber or felt.

The frame is anchored to the wall with two 1/4x2-inch iron anchors on each side.

The door plug should be braced by two 3/8-inch rods set diagonally in the center of the plug between the two layers of cork board.

Hinges and fasteners should be put on in the same manner as described for the hinged cooler window.

Fireproof Cold Storage Windows

Where the openings must be protected by fireproof windows, these should be made separate from the cold

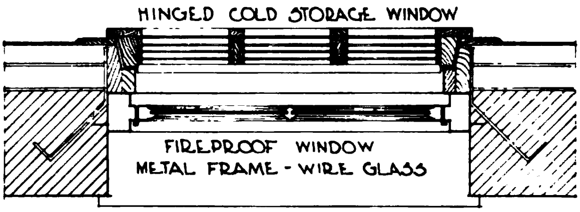


FIG. 138—COLD STORAGE WINDOW PROTECTED BY FIRE UNDERWRITERS STANDARD WINDOW.

storage window and placed in the position shown by Figure 138. This simplifies the construction and is approved by the underwriters.

CHAPTER XIX

FLOORS

Packing House Floors

Packing house floors are required to withstand more wear and tear and hard usage than is ordinarily expected of floors in manufacturing buildings. This is due principally to heavy trucking and to constant cleaning and washing up with hot water. In many departments there is also a great deal of hot grease and oil spilled on the floors, which deteriorates the surface. Under these conditions it is difficult to lay a floor which will successfully stand years of hard service and still remain in a satisfactory and sanitary condition.

The materials must be selected with the utmost care and the workmanship in the laying of the floor must be of the very best. This is particularly true of asphalt and concrete floors where the mixing and handling of the materials require skilled workmen, who thoroughly understand how the floors should be laid.

The drainage of the floor should be sufficient to rapidly carry off the water to the gutters and drain outlets. Too much stress cannot be laid upon the fact that where there is a depression or unevenness in the floor, in which water is allowed to stand, such places will show signs of wearing out, long before the rest of the floor is affected. For this reason too much attention cannot be paid to having an even, smooth wearing floor and the time to insist upon this is when the floor is being put down. Afterwards it is too late, as the floor cannot be satisfactorily patched or remedied.

The varied construction of packing house floors has brought into practical use all kinds of materials for floor

surfaces, some of which are better adapted to certain conditions than others. There are, however, differences of opinion as to which kind of materials to use in various departments, particularly so with regard to the use of asphalt and concrete. The poor results which some owners have had with floors of this kind have made them condemn these entirely, regardless of the experience which others have had.

In a general way it can be said that asphalt is not well adapted for use where there is hot water and grease being spilled on the floor, and where there is excessive trucking.

The same can be said, to less extent, about concrete, although these floors are greatly improved by using floor hardeners in the wearing surface.

Wood Floors

These are satisfactory only when they remain watertight and are laid with the kind of wood which will most effectively resist dampness. For this reason, long leaf yellow pine should be used, as it will outlast any other flooring, when clear edge-grain stock, containing a high percentage of rosin or natural gum, is selected. A cheaper grade of underflooring is first put down and covered with waterproofing material, over which the edge-grain wearing floor is placed. This should be one and three-fourth inches thick for all manufacturing floors and seven-eighths inch thick in beef and hog hanging coolers.

The floor should be tongued and grooved, and blind-nailed every 12 inches with galvanized flooring nails and each board should be driven up tight against the flooring already laid.

All ends or ridges should be planed off after the floor is finished, in order to remove any unevenness which could hold back the water. Such pockets are the starting points of decay in the floor and it will wear out in these places long before the rest of the floor shows any signs of rot.

The waterproofing should be laid with not less than four ply of odorless, saturated felt, weighing 15 pounds per 100 square feet. Each layer should be thoroughly mopped

with odorless pitch or asphalt, applied hot and generously. The success of the waterproofing depends principally upon the care with which it is put down. This refers particularly to the floor at the wall lines, posts and around all openings. The waterproofing must be carefully fitted around the posts and carried up behind the protecting cant strips placed along the wall.

With waterproofing floors a 3x3-inch cant strip should be placed at all intersecting points; that is, where the walls or posts intersect the floor. These strips should be put wherever an aperture exists through which water could pass. The strips should be carefully mitered at all corners and angles and the joints driven up with oakum and filled with a high grade of pine tar pitch. It will be necessary to refill the joints around the posts after the wood has shrunk away from the cant strip.

Caulked Wood Floors

Heavy plank floors laid with caulked joints are frequently used when there is little trucking over the floors. The planks should not be less than three inches thick, while four inches is required in mill construction.

The width should be from eight to ten inches and the wood must, therefore, be flat sawed or slash-grained. The joints at the side are beveled and caulked with oakum and then filled with a high grade of pine tar pitch.

Flat sawed flooring has a tendency to splinter when the floor begins to wear, and is, therefore, not recommended for use in departments where there is much trucking. An edge-grain flooring four or six inches wide will give better results.

It will be necessary to recaulk the joints from time to time, as the pitch is carried away by frequent washing. When the work is thoroughly done a caulked floor will remain watertight indefinitely.

Asphalt Floors

Asphalt had been extensively used in packing house work with good results where the conditions favored its use

and the workmanship and materials were of the highest grade.

Commercial asphalt is obtained from several sources. We have the rock asphalt which is manufactured from a limestone or sandstone rock, heavily impregnated with asphalt. The percentage of the latter substance may vary from 15 to 30 per cent. This rock is mined in many countries in Europe and also in the states of Utah, New Mexico and California.

The so-called lake asphalt is produced in Trinidad and Bermudez and consists of asphalt substances mixed with clay and fine sand. The principal difference between the asphalt found in these two localities is that the Trinidad product is much harder than that of Bermudez.

Gilsonite, which is found in Utah, is perhaps the purest form of asphalt in its natural state. It will analyze over 99 per cent of bitumen.

Before the natural asphalt can be used as a material for construction it must be dried and mixed with other substances in order to make it of the proper consistency. This prepared substance is called Mastic and the formulae which are used by various manufacturers in the preparation of their product is their trade secret.

The American Asphaltum Co. claims that their Mastic is a mixture of asphalt rock, from their own mines, and Gilsonite.

The Barber Asphalt Co. claims that theirs is composed of a mixture of Trinidad, Bermudez and imported asphalt rocks.

There are other materials which have entered into the preparation of mastics, such as the residue left from the distillation of crude oil into petroleum, coal tar, tar pitch, etc.

When the mastic is used for flooring it is mixed with about 20 per cent of flux, which is a softer material made from petroleum residuum and a certain amount of sand and fine gravel. This mixture is heated in kettles for about

five hours and cooked under continual stirring until the ingredients are thoroughly mixed.

It is generally laid over the floor in two courses of about ¾-inch thickness each. The floor is first covered with a layer of heavy building paper with overlapping joints. Each layer of asphalt is worked with wooden spalls until it is entirely free from voids and a smooth, even surface is obtained. Over the top coat is sprinkled dry Portland cement while the finish is being troweled and rolled.

The asphalt mixture used in packing houses should vary with the temperature of the rooms in which it is used. A higher percentage of mineral matter, which gives a stiffer and harder floor, should be used in warm places. A mixture containing more bitumen and less mineral matter is better suited to cold storage rooms, where a softer and less brittle floor is more desirable.

In a general way, it may be said that asphalt is subject to deterioration when in contact with water, grease and oily substances. Cold water is not injurious to any great extent unless the floor is subject to considerable wear along with the water action. Hot water disintegrates the floor very rapidly, when it is also subject to wear. Hot grease and oil will disintegrate asphalt instantly and should, therefore, be kept off the floor absolutely.

The life of the floor depends upon the evenness with which the floor is laid and upon the action of foreign substances, as well as the amount of trucking on the floor.

Asphalt will not crack, when properly laid. It is durable, sanitary and easily kept clean and is, therefore, one of the best flooring materials in use at the present time.

Concrete Floors Laid Over Wood Floors

The following specification for laying concrete floors over wood floors is used by one of the largest Chicago packing companies, which has had much experience in laying such floors:

1—Mop the floor with hot Asphalt or Roofing Pitch.

2—Then lay 4-ply of best Roofing Felt, each layer to be mopped over its entire surface with hot Asphalt or Roofing Pitch. While the

Asphalt is still hot cover the floor surface with ¼-inch of gravel, clean and well screened.

3—Then lay 1½ inches of concrete mixed in proportion of one part of Portland Cement to four parts of crushed granite, screened to pass through a ½-inch ring. On top of this lay poultry netting.

4—Floor to be finished with 1½ inches of concrete of the same mixture as above and troweled to a smooth, even surface, using dry cement when troweling.

5—Floor to have expansion joints so that each bay will be divided into four equal squares. Joints to be ¼-inch thick and filled with hot asphalt after the concrete is dry.

Monolithic Concrete Floors.

The rapidity with which concrete has become the standard building material for industrial plants is an indication of its increased use in the future in packing plants and cold storage buildings.

Concrete has already replaced wood, wherever possible, in most of our modern packing plants, due to the durability, strength, and fireproofness of this material.

In connection with the use of Portland cement concrete in packing plants, there has been a tendency to overlook certain limitations of this material. When, in consequence, the concrete has failed to give the expected satisfactory result, the blame for this should be laid to the lack of precautionary measures rather than to the inherent fault of the material. It should be clearly understood that concrete, on account of its porosity, is not in itself waterproof. Neither is it of sufficient hardness to resist, for any length of time, the continued action of heavy trucking on the wearing surface.

The porosity of concrete is a natural and inseparable property of the material. This is partly due to the excessive amount of water which is needed to provide a mixture of the proper liquid consistency that will permit of the material being properly placed in the form. The water which has not entered into chemical reaction with the cement will evaporate and impart a porous, capillary nature to the concrete.

The variation of the aggregates of which the concrete is mixed leaves a certain percentage of voids, since it is impossible to secure an absolute uniform run of crushed

stone, gravel and sand. The extent to which the concrete will withstand hydrostatic pressure will depend largely upon the proper selection of ingredients and the care used in the mixing and placing. The aggregates should be graded so as to secure the best results in filling the voids. The sand should just fill the interstices of the stone and the cement should be sufficient in quantity to fill those of the sand. The proper proportioning and careful mixing of the ingredients are of the greatest importance in good concrete work. It is a mistaken idea that if enough cement is put into the concrete the mixing can be neglected. A lean mixing of concrete may be far superior to a rich one if the mixing of the ingredients is more thorough.

The concrete should be carefully placed in the forms and not dropped from a greater height than is absolutely necessary, so as not to separate the ingredients. The mixture should be well stirred and spaded, particularly along the form, so as to avoid honey-combing. The importance of having tight forms should not be overlooked, since loosely constructed and leaky forms will allow the cement and water to seep out. The necessity for carefully joining old and new concrete work, where this is required to resist water pressure, is evident, when we find water seeping through at the joints between different days' work. The surface of the old concrete should always be roughened and cleaned off before the new concrete is placed, and the first batch of this should be a grout of 1-1 cement and sand.

Waterproofing Concrete

It is now generally understood that to obtain a satisfactory waterproof concrete it is necessary to overcome the inherent porosity of the material. This is done either by the waterproofed concrete method or by the cement coating process.

In the first method the voids in the concrete are filled by a waterproofing compound which is mixed in with the mass concrete.

By the cement coating process a facing of waterproof cement mortar is applied over the rough concrete floor or

on the wall surface in such a manner as to be securely bonded to it. It then acts as a wearing floor, or where it is applied to the inner surface of the wall, as a wall plaster. Too much confidence, however, should not be placed in waterproofing materials unless the concrete itself is of the proper mixture and has been carefully placed, since waterproofing is not to be looked upon as an all-cure for defective materials and workmanship.

The manufacturer's specifications for mixing and applying any waterproofing material should be carefully followed in order to obtain the best results, and the concrete should be protected from contact with water or exposure to the sun until the final set has been attained and it is capable of resisting the destructive action of such exposure.

Concrete Floor Finish

The usual method of finishing concrete floors is to put down over the concrete slab one to one and one-half inches of cement mortar, mixed in the proportion of one part Portland cement to two parts of clean sharp sand. This is then troweled to an even, smooth surface and left to set and harden. Such floors do not work satisfactorily where there is much water and the trucking is heavy. This may be partially due to improper mixing and workmanship, but the principal fault can be laid to the porosity of the wearing surface.

A better floor is obtained by using a mixture of cement and granite screenings. These should be in two sizes, one which will pass through a ¼-inch screen and a larger size which will pass through a ½-inch screen. The screenings should be free of dust and mixed together in the proportion of two parts of fine to three parts of coarse. The mortar is mixed in the proportion of one part of Portland cement to two parts of screenings and should be applied over the concrete slab in one and one-half inch thickness.

The surface should be troweled to an even surface, using a still float. Excessive troweling should be avoided, also the practice of adding cement to the surface to temper

the mortar, since this causes the finished surface to crumble and disintegrate.

The finish should be laid over the rough concrete slab before the concrete has hardened. This adds greatly to the strength of the floor and makes the construction homogeneous. The objection which is sometimes made against this method of construction is that the finish may be ruined by being walked on by the workmen erecting the false work for the construction above. By carefully protecting the finish with dry sand or sawdust after the floor has begun to harden, this difficulty can be overcome. The floors should be kept damp by constant wetting down for a period of 10 days after completion.

Excessive trucking will wear out even the best floors, and it is therefore recommended that the trucking alleys be paved with vitrified bricks. These will withstand trucking for long periods and can easily be replaced when required.

Floor Hardness

The only way to obtain a satisfactory wearing floor of concrete is to mix with the cement mortar a substance which will fill the voids in the top surface of the floor and thereby prevent granulation. It will also make the floor more waterproof, less absorbent and eliminate the dust, which is always present on ordinary concrete floors. The best hardeners are those which are mixed with the sand and cement when the topping of the floor is put on. They fill the pores of the concrete sufficiently deep below the top surface to make this a dense, hard body, which will withstand the action of water and truck wheels much longer than the ordinary cement and sand finish. There are other hardeners which are applied as a surface treatment or filler, but their value, in packing house floors, would be only on account of their dustproof or waterproof qualities.

In applying any of the many excellent hardeners on the market, the manufacturer's specifications should be followed in order to obtain the best results. A word of caution may here be said against the use of any of the untried

hardeners or waterproofing materials on the market. Record of years of actual service in buildings ought to be the only guide which the purchaser should follow in selecting the material.

Brick Floors and Paving

The use of brick and tile, as a wearing surface, over wood or concrete floors, has been generally adopted for killing floors, loading platforms, live stock pens and runways, and it is also frequently used for the floors of trucking alleys in meat curing rooms and cold storage buildings.

Only selected hard burned, vitrified brick is suitable for floors where there is much water. The common hard building brick is too porous and absorbent and will quickly wear out. The vitrified paving brick of the ordinary type is too heavy for use inside of the building. There are, however, special-made bricks and tile, which are well suited for all purposes.

The Garden City Sand Co. of Chicago, Ill., makes a good vitrified brick of a size 2x2x7¼ inches with lugs on the side to separate the bricks as they are laid.

The McLean Firebrick Co. of Pittsburgh, Pa., makes a hard-burned, vitrified floor tile 4x8x1½ inches thick. This is made in two shades, light and dark brown, and makes a very serviceable and sanitary floor.

The bricks are laid without mortar in a ¾-inch bed of sand. The joints should be broken and should not exceed one-eighth of an inch in thickness. After the floor is laid the surface is slushed with Portland cement grouting and the joints thoroughly filled and grouted. The slushing should be repeated until all joints are completely filled. Hot asphalt is sometimes used instead of cement for filling the joints, but it is not recommended for use in places where hot water or grease is spilled on the floor.

Where brick paving is placed over cellar floors there should be a base of four inches of concrete laid on the ground as a foundation for the paving.

Pavements in live stock pens are laid with common vitrified paving brick, placed over an 8-inch bed of dry

cinders, which is thoroughly tamped down and evenly graded to the drain outlets. The brick is laid with a cushion of sand and the joints slushed with cement grouting in the manner specified above.

Pavements of inclined runways must be laid so as to provide secure footholds for the live stock; therefore the brick should be laid in continuous rows, with three bricks flat and alternating with one course on edge. The edgewise brick should stop within 12 inches of each side of the run in order to allow the water to pass down.

The cost of a brick pavement laid over a concrete base will average about $1.35 per square yard, and laid over a cinder fill the cost will average about $1.00 per square yard.

The quantity of brick required, when laid on edge, is 60 brick per square yard, and when laid flat, 36 brick per square yard.

CHAPTER XX

CONSTRUCTION DETAILS

Floor Gutters

These are made of concrete, wood or cast-iron, according to the construction of the floor in which they are placed. The advantage of gutters over other types of floor drains is the rapid disposal of the water on the floor, and in the reduced number of drain outlets, traps and plumbing connections needed to carry off the water to the sewers. The objection which is raised by many against the use of gutters is based principally upon the difficulty of keeping them watertight and the inconvenience of trucking over the gutter boards. Gutters in wood floors are not as satisfactory as in concrete construction and they must be carefully built if they are to remain tight. Cast-iron gutters are sometimes used in wood floors and then always in sections about eight feet long, bolted together. The joints are caulked with lead to make them watertight. They are expensive and not very satisfactory where there is much vibration in the floor, which is generally the case in packing houses.

A better construction would be to line the wooden gutters with copper or tin and thoroughly solder all joints after they had been nailed.

Gutters in Concrete Floors

In Figure 139 is illustrated a method of constructing the gutters in concrete floors. The sides are made with 6-inch channel irons set 10 inches apart and anchored to the concrete with ½-inch bolts on six-foot centers. The bottom of the gutter is finished with Portland cement mor-

tar and made to slope with a 3-inch pitch towards the drain outlet. This is placed in the concrete floor before the cement has set and is made with a 4-inch threaded nipple, 12 inches long, onto which a standard 4-inch pipe flange has been screwed to hold the nipple in position. The gutter boards are made with two 2x4-inch oak boards bolted

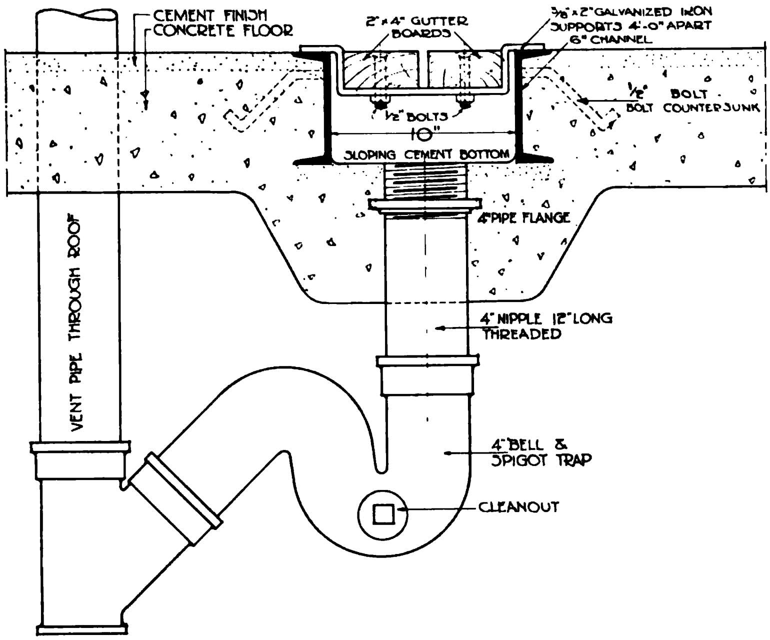


FIG. 139—DETAIL OF GUTTER IN CONCRETE FLOOR.

to galvanized iron carriages $3/8$x2 inches, spaced four feet apart. The bolts are $1/2$ inch in diameter, with countersunk head and galvanized.

Wood Gutters

In Figure 140 is illustrated the construction of a wood gutter. The sides are made of 4x10-inch and the bottom of 3x12-inch clear fir. The sides are rabeted one inch for the bottom piece, which is placed with a slope of four inches toward the drain outlet. The joint is painted with white

lead and oil and two lengths of seine cord dipped in paint are stretched from end to end, before the gutter is put together. The sides are drawn up tight with 5/8-inch bolts, spaced two feet on centers. When the gutter must be made in sections, the lumber should be bought in the largest length obtainable, in order to reduce the number of joints. The ends must be halved and thoroughly painted before

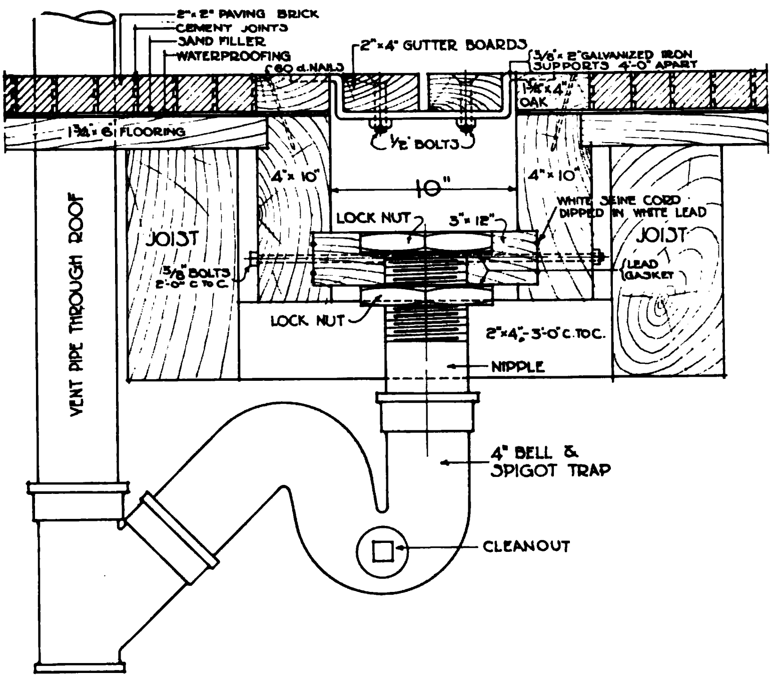


FIG. 140—DETAIL OF WOOD GUTTER

they are put together and then bolted with 1/2-inch carriage bolts, placed with the head on the inside of the gutter. The joints in the side pieces should never be placed at the same point as the joints in the bottom piece. The 4-inch nipple for the drain outlet is put on with two lock nuts and screwed up with lead gaskets between the lock nut and the wood.

The floor is finished at the edges of the gutter with an oak curb, 1¾x4 inches, securely spiked with galvanized iron spikes, 16 inches apart.

The gutter boards are made in the same manner as specified for concrete gutters and the carrying irons are housed into the oak curb.

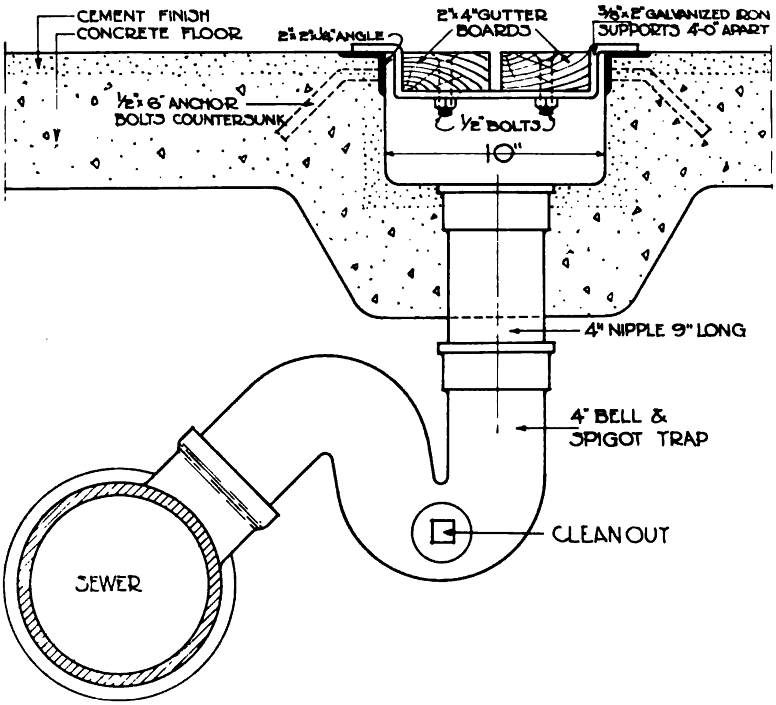


FIG. 141—DETAIL OF GUTTER IN CELLAR FLOOR.

Gutters in Cellar Floors

In Figure 141 is illustrated a gutter designed for concrete floors in cellars. The curb at the floor line is protected by 2-inch angle irons anchored to the concrete with ½-inch anchor bolts, six inches long and spaced six feet apart. The drain outlet and trap must be placed before the gutter is built.

Inserts in Concrete Ceilings

With reinforced concrete construction, it is necessary to provide inserts or bolts in the ceiling for the support of the piping, shafting, electric wiring, or any other equipment which will be hung from the ceiling.

Inserts are preferable to bolts because they are made a part of the concrete slab and the bolt for supporting the equipment can be slipped in or out afterwards. On the other hand, if the bolts are built into the slab they cannot be renewed, if they rust out, except by drilling the concrete for the new bolt.

Inserts should be placed in the ceiling wherever any equipment is required for immediate or future use and where the future requirements cannot be definitely arranged for at the time the building is erected, it is always

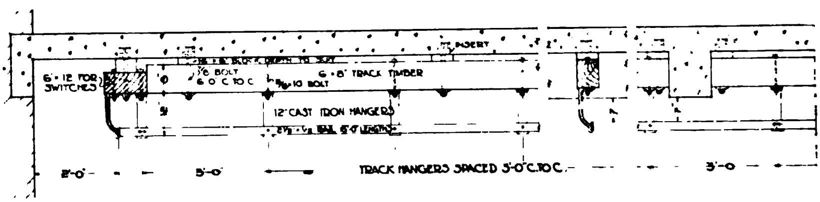


FIG. 142—DETAIL OF TRACK SUPPORTS.

a good plan to provide inserts over the entire ceiling. They should be spaced about eight feet apart, so that the lumber for supporting the machinery can be bolted to the ceiling wherever requirements will demand.

Detail of Overhead Track Supports

In Figure 142 is illustrated a method of supporting overhead trolley tracks from a concrete ceiling. Inserts are placed about six feet apart and support the ⅞-inch bolts for the track timbers. These are made of 6x8-inch yellow pine and hung at the proper height for the track. When this is placed high and very close to the ceiling, it will be necessary to make the concrete ceiling above sufficiently high to allow at least three inches for the tightening up of the hanger-bolts.

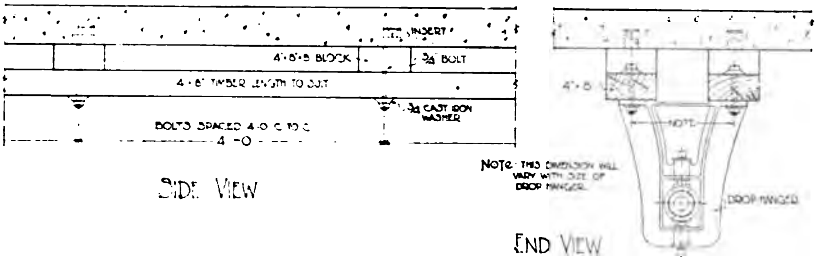


FIG. 143—DETAIL OF SHAFT HANGER SUPPORTS.

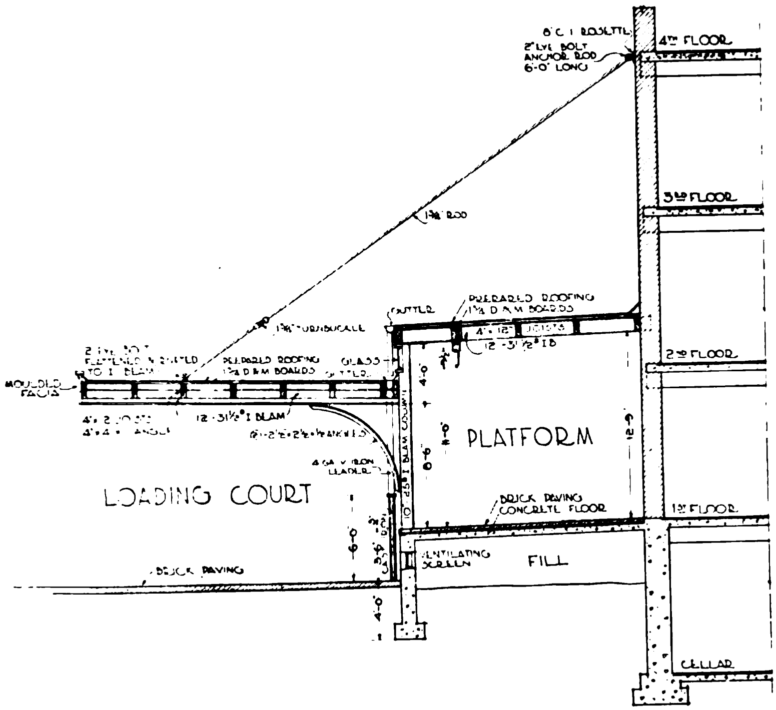


FIG. 144—DETAIL OF LOADING COURT—SHOWING AWNING OVER PLATFORM.

Details of Support for Shafting

In Figure 143 is illustrated a method of supporting the shafting from the concrete ceiling. The hangers are fastened to two 4x8-inch yellow pine timbers, which are bolted to the ceiling with ¾-inch bolts. The timbers are

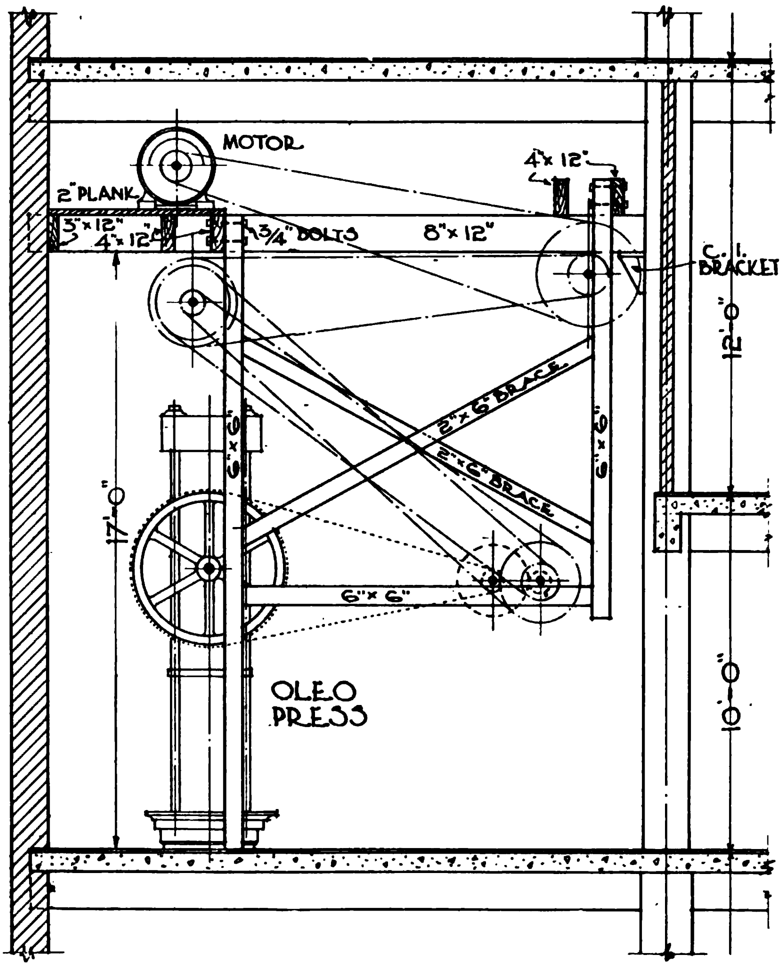


FIG. 145—SECTION SHOWING DRIVE FOR OLEO PRESS.

laid flat and placed as far apart as will be needed to provide support for the shaft hangers. This distance should be determined by figuring the size of the hanger before the inserts are placed.

CHAPTER XXI

PAINTING

Paints and Painting

Paints are now extensively used in packing houses and cold storage buildings where formerly the walls and woodwork were left unpainted.

It is one of the requirements of the Bureau of Animal Industry that the woodwork in packing house departments where edible products are handled or stored, must be painted. In rooms where there is much moisture, the paint must be non-absorbent and must, therefore, be either an oil paint or a good grade of varnish. In rooms where the air is dry, cold or hot water paints may be used.

The Bureau recommends the use of paints of light color, so that any accumulation of dust or dirt can be readily seen and removed, thereby assisting in maintaining cleanliness. All materials used in the preparation of paints must be free of strong odors, particularly when used in refrigerated storage rooms.

Paint is sold in cans or barrels, mixed and ready for use, or it can be bought in the form of a paste in 25, 50 and 100-lb. kegs, which paste requires thinning with oil or turpentine before it is used.

Pigments are sold in powdered form and added according to the color desired.

The proportion of ingredients in paints will depend largely upon whether it is to be applied to masonry, wood or metal and how many coats of paint are to be used. Turpentine should not be added to paint except when it is used over old work, to make it adhere better to the old paint. There is a great variety of factory-made paints and enamels

which are put up in liquid form, ready to use, and where brands of known quality and durability are obtained, they will, undoubtedly, give better results than if the paint is mixed on the job. This is particularly true of metal paints and enamel finishes. White paints which are made with white lead should not be used in rooms where the air contains much hydrogen sulphide. This acts on the white lead in the paint and quickly turns this to a dark color. Only white zinc and oil should be used for light colored paints.

Paints for Brick and Concrete Walls

Foremost among the paints for painting masonry walls and plastering, particularly for interior work, are the China Wood Oil paints. They dry quickly in moist atmospheres and produce a waterproof surface which may easily be washed at any time. These paints will, when properly mixed, outlast the ordinary white lead and linseed oil paint, which is commonly used in packing house work.

Paint for Woodwork

All exterior woodwork should be preserved by painting with at least two coats of white lead and linseed oil paint. The woodwork inside the building should either be painted or varnished.

In mill constructed buildings the Underwriters object to oil paint or varnishes being used on the structural parts of the building, since they increase the fire hazard. They recommend the use of white-wash and fire-retarding paints in rooms where the moisture in the air will not prevent this kind of paint from adhering. The Bureau of Animal Industry strongly objects to whitewash being used in rooms where edible meat products are manufactured or stored, and a fire-retarding paint is therefor recommended.

All wood in concrete building should be painted with two or more coats of white lead and linseed oil paint.

In coolers, sales-rooms, and packing rooms, where an attractive appearance is of more importance than in other parts of the plant, the woodwork may be finished with one

or two coats of white enamel paint applied over one or two coats of priming.

Paint for Steelwork

The exposed steelwork in packing plants needs to be painted thoroughly and at regular intervals, on account of the unusually severe corrosive atmospheric condition which always exists around packing houses.

The best paints for steel have been proven, by experiments, to be: graphite, carbon, iron oxides, and red lead, in the order named, with a slight preference for the first two paints.

The paint should be thoroughly worked into all corners and crevices and should be applied as thickly as the painter can put it on.

Red lead should only be used for the priming coat as a preserver and must be covered over with other paints to protect it from the action of gas and sulphur.

Cold Water Paint

Cold water paints are much used on brick and concrete walls and on rough boards and fences in stock yards. They are less expensive than oil paints and are therefore used on cheaper work. They are sold in powdered form and mixed with water in the proportion of five pounds of powder to one gallon of water. This amount of paint will cover about 200 square feet of rough surface and about 300 square feet when applied on surfaced lumber. Cold water paints are preferable to whitewash in that they do not flake off as readily.

Whitewash

This has been extensively used both in packing houses and cold storage plants. The Government now objects to its use in any packing house departments where edible meat products are handled or stored. It flakes off on walls and ceilings and is therefore objectionable.

Whitewashing is the cheapest way of improving the appearance of walls and woodwork and will prevent the woodwork from being affected by stale odors and thus taint the goods in storage.

It should be applied in two coats on unpainted wood and the first coat should be applied very thin and be thoroughly dried out before the second coat is put on.

Whitewash is made with pure, white lime, slacked in hot water. To this is often added salt, powdered rice, powdered whiting, glue, cement, or other ingredients to make it more white and durable.

The Government specification for whitewash is as follows: Slake half a bushel of quick lime with boiling water, keep it covered during the process. Strain it and add a peck of salt, dissolved in warm water, three pounds of ground rice put into boiling water and reduced to a thin paste, half a pound of powdered Spanish whiting, a pound of clean glue, dissolved in warm water; mix these well together and let the mixture stand for several days. Keep the wash, thus prepared, in a kettle or portable furnace and put it on as hot as possible with either painters' or whitewash brushes.

CHAPTER XXII

INSURANCE AND FIRE PROTECTION

Introduction

The recommendations of the fire insurance companies should be carefully considered in the planning and construction of packing plants. Their recommendations are based upon experience gained through untold numbers of fires in all classes of buildings, and are, therefore, to be looked upon as the last word in safe and sane construction.

Those who regard first cost as the one essential to be considered when building, will undoubtedly object to many features, which may seem to them unnecessary and expensive, but, all of which have the one object in view, namely, to reduce the fire risk to the minimum.

By following the rules recommended by the insurance companies, the owner knows that he will obtain the lowest possible rate of insurance on his plant, and he may also feel assured that he has not only safeguarded the lives of his employees but has done much that will insure him a permanency in his plant investment.

Until recent years the cost of fire insurance to the packers was high, compared with the rate paid by other manufacturing industries. This was partly due to the nature of the business with the numerous by-product processes in which fires will always be of frequent occurrence. The main cause, however, of the high rates, was the grouping of large values and many processes between fire walls, under one roof, in disregard of the fundamental principles for the conservation of property, upon which the insurance companies base their rates.

The many large and destructive fires in the past, caused by this neglect, therefore, made it necessary for the companies to place their rates on a basis which seemed high when compared with similar buildings in other industries, and it is imperative that the owner comply with the principal insurance requirements, if he intends to carry insurance and expects to obtain a favorable rating on his plant.

The increased cost of buildings constructed with the view of reducing the insurance premiums, is so small, in comparison with the benefits derived, that all new buildings should embody every important recommendation made by the insurance companies.

Different basis rates have been established, based upon the principal occupancy of the buildings, so that each building within a plant is rated differently. Thus, a cold storage warehouse would be rated lower than a slaughter house and this again lower than a tank house or fertilizer building.

This should be considered, when planning the arrangement of a plant, so as to obtain full advantage of the various ratings. Buildings which have two or more classes of occupancy, will take the basis rate of the class which is considered the greatest fire hazard and this rate will apply to the entire building.

Fireproof construction should be used where the available funds will permit the increased expenditure. The difference of cost between fireproof and mill construction will be between 10 and 15 per cent, depending upon the character of the buildings and the locality in which they are built.

The saving in the insurance rate as well as in the maintenance of the plant, will greatly reduce the yearly operating cost.

The improved sanitary conditions and the lower charges for depreciation in fireproof buildings, are other features which should be carefully considered before the question of construction is finally decided.

Area of Buildings

One of the most important recommendations of the insurance companies is that the floor area of a building should not be excessive. The area of the building should be governed by the type of construction, height, and location, and these factors are all taken into consideration by the insurance raters in arriving at a penalty charge for excess area in their rating schedule.

Fire Walls

Standard fire walls of brick must be built between two buildings adjoining each other and all communication between the buildings should be through fireproof vestibules, built around the doorways. For this reason, the doorways ought to come one above the other and in the same position on all floors, so that the vestibule can be built continuous from cellar to roof.

Vestibules

The vestibule is generally made large enough to include the elevator and stairway, with a trucking passage not less than eight feet wide in front of the elevators.

All door openings must be provided with approved fire-doors on each side of the wall, in order to comply with the standard requirements of the Underwriters.

Where is becomes necessary to place a direct opening in a fire wall, that is, without a vestibule being built around the opening, there is always an additional insurance charge, even when standard fire doors are used on the opening; therefore, the practice of placing doors in fire walls indiscriminately should be avoided, when this can be done without too much inconvenience in handling the products from one building to another.

Exposures

Practical requirements may sometimes compel the designer to conflict with the insurance recommendations. It may be advisable, in many instances, to separate two buildings and give light and ventilation to both, but it may not be practical to place them sufficiently far apart to eliminate an exposure hazard.

To avoid any exposure charge which may be imposed, it becomes necessary to protect all exposed openings with approved fire shutters, doors, or wire glass metal frame windows.

Outside Communications

Bridges and passageways used for communication between buildings, should be of fireproof construction and, if built of wood, covered on the outside with metal. Covered bridges require fire doors on all openings leading to the bridge and it is, therefore, cheaper to build these structures with open sides, where possible. Loading platforms, icing sheds, runways and similar structures, which are generally built of wood, will increase the insurance rate on the adjoining building and they, therefore, should be of fireproof construction. The writer knows of a fireproof cooler building where the insurance rate was reduced 17 cents, when the construction of a platform and awning which was built on two sides of the building, was changed from wood to fireproof construction.

Fire Doors

The great importance of fire walls in preventing the spread of fire, and the fact that they are liable to be severely exposed to fire for considerable periods, makes it essential that all openings in such walls be protected by the most efficient methods. Only such fire doors should be used as have been shown by experience and tests to furnish a high degree of fire protection if installed on both sides of the wall.

There are two general types of fire doors which are recommended by the insurance companies, one being an all steel door, hung from an angle-iron frame, and the other is a tin covered wooden door, which is hung either from an angle-iron frame or from hinge-bolts built into the brick wall. There is some difference of opinion as to the efficiency of the two types, and it is well to confer with the rating or inspection bureau of the insurance companies having jurisdiction over the territory in which the plant is located, before deciding on the type. For instance, the Chicago Board of Underwriters recommends the steel door

while in the Minneapolis district the tin clad door is preferred.

Where it is immaterial to the Underwriters which type of door is used, the author recommends that the steel door be installed in packing plants and cold storage buildings. The tin covered door is too easily damaged by trucks or barrels being knocked up against it and when once the tin covering is torn and punctured so that it leaves the wood exposed, the value of the door as a protection against fire is void. This is the principal reason why tin covered doors are not permitted in Chicago. The experience has been that the doors are frequently damaged and that this remains neglected by the owner who does not, as a general rule, repair the door until he is compelled to do so by the insurance inspector. Another objection to the door is that the wood inside the tin covering is easily attacked by dry-rot fungi, which has, in many instances known to the Underwriters, destroyed the wood in the course of a few years.

The Underwriters' Laboratories, Inc., makes the following comment upon tin-clad fire doors with 3-ply wood cores: "Standard tin-clad fire doors are fairly substantial in construction, practical under most conditions, and easy to install. Doors on both sides of the wall furnish a high degree of resistance to fire and to the transmission of heat for long periods of exposure, and resist fire streams well. Under adverse conditions of service, they are liable to deteriorate rapidly and are difficult to maintain."

The steel door has none of the above objections and will outlast any tin covered door, if it is kept painted. The only objection, aside from the cost, which can be made against the steel door, is that it has a tendency to buckle under the heat of a severe fire. But, even if the door on the side of the wall nearest the fire should fail, it will offer enough resistance to prevent the door on the other side of the wall from being similarly affected.

This was clearly demonstrated in 1914, when a packing plant in Nashville, Tenn., was partly destroyed by fire.

The complete destruction of the plant was prevented by a fire wall in which all openings were protected by steel doors. When the building collapsed, it was seen that the steel doors, in some instances, had buckled away from the frame, but in no instance had the second door been damaged.

The Underwriters' Laboratories, Inc., have made the following comment upon standard iron doors of vault pattern: "They are substantial in construction, practical under most conditions and easy to install. Doors on both sides of wall furnish a high degree of resistance to fire and to the transmission of heat for long periods of exposure. They resist fire streams well, and are durable and easy to maintain."

Rolling steel fire doors are often installed where swinging or sliding doors cannot be employed. They are accepted as good fire protection by the Underwriters, if of approved construction. Their comment upon this type of door is as follows: "Standard rolling steel fire doors are substantial in construction, practical under most conditions, but are difficult to install. Doors on both sides of wall furnish a high degree of resistance to fire and a fairly high resistance to the transmission of heat for long periods of exposure. They resist fire streams well, are durable, fairly easy to maintain, and are capable of being installed in locations where space limitations prevent the installation of other types of doors. They are difficult to operate, especially after they have closed automatically, and their use in any given case should be considered in its relation to effect upon hazard to life."

Rolling doors should not be used in firewalls where the size of the openings exceeds 80 square feet.

Fire doors for openings in vertical shafts, such as elevators, stair-wells, and beef drops will prevent the rapid spread of fire from floor to floor. While they are subject to fire exposure of the same severity as doors in firewalls, the conditions in vertical shafts are such that single fire doors can safely be employed at each opening in standard built shafts.

This is permitted by the Underwriters for the reason that the failure of two doors, always located a considerable distance apart, must occur before fire can pass from one story to another.

Fire-Retarding Windows

These windows, in order to be approved by the Underwriters, must be examined at the factory in which they are made, by the Underwriters' Laboratories, Inc. If the construction is passed, the windows are labeled with a metal tag which is riveted to the frame. The label is evidence of proper construction and material.

The most common type of fire retarding window is made with a hollow metal frame and sash, glazed with wire-glass. The maximum size of frame which may be used is 5x9 feet, when the frame contains two or more sash; with single sash the opening must be limited to four feet, six inches by five feet, except that single sash casement windows may be made with three feet, six inches by nine feet frame. The glass must not be less than $\frac{1}{4}$-inch thick and cannot be over 48 inches in either dimension or exceed 720 square inches. Where openings are in excess of 5x9 feet, mullion windows may be used; in which case the mullion must be reinforced by five-inch I beams protected by a fireproof material.

Wrought iron window frames can be used to advantage in packing plants when the unusually severe corrosive atmospheric conditions limit the life of the ordinary sheet metal windows. The frame and sash may be galvanized and the size of the glass must not exceed 216 square inches in fire-retarding windows. The largest size opening allowed is forty-five square feet or 5′-0″x 9′-0″. The pivoted or stationary window seems to be the best adapted when wrought iron frames are used. If the stationary window is installed, the frame may be dispensed with and the sash placed in the opening and securely anchored to the wall.

Skylights

This term is used by the Underwriters for any opening through the roof for the admission of light. In pack-

ing houses the most common type of skylight is the monitor or lantern type, which is generally made continuous as a raised section of the roof, with vertical sash. The peaked skylight with inclined sides is generally used over stairs and elevator shafts, and there are flat skylights, sawtoothed roofs, ventilating skylights, etc.

The monitor skylight should be built to conform with the construction of the roof of which it forms a part. When this is of wood, the monitor must be covered on the outside with tin and when the roof is of concrete the sides of the monitor may be made of brick, tile or concrete. All frames and sash must be of galvanized or wrought iron and the sash glazed with ¼-inch wire glass.

Flat or peaked skylights must be made with galvanized iron frames, riveted to angle irons and securely fastened to the roof construction. The glass must be wire glass ¼-inch thick, or may be plain, clear glass ½-inch thick, protected with heavy wire screens. The panes must not be over 20 inches wide nor exceed 720 square inches in area.

Fire Protection

The private fire protection of packing plants and cold storage buildings should be of the highest type of efficiency. The value of the products which are held in storage is generally high and in packing plants, the hazard in many of the manufacturing and by-products processes is unusually severe, and ample fire protection is therefore strongly urged by the insurance companies.

Provision should be made for an ample water supply, made properly applicable to any part of the plant through standpipes and hose. When a natural source of water supply is not available, storage reservoirs of ample capacity should be provided and a firepump installed which will furnish the required pressure to all standpipes. These features all tend to materially reduce the insurance rate and will furnish immediate means for fighting a fire once started.

Sprinklers

Up to four years ago the insurance companies were somewhat skeptical as to the efficiency of automatic sprink-

lers in a greater part of packing plants. There was also objections on the part of the owners to the installation of sprinklers on account of loss of headroom and obstructions to manufacturing processes. Today, however, the insurance companies are strongly advocating sprinkler protection and they are allowing practically the same credit in rates as allowed in the average manufacturing plant. This credit will range from 70 to 80% of the rate on unsprinkled buildings.

Another feature which should be considered when sprinklers are installed is that the area and height of buildings are not penalized in rate. This may save the cost and inconvenience of fire walls, vestibules, etc., where these can be omitted by the installation of sprinklers.

In view of the now established efficiency of automatic sprinklers and the attractive reduction in rate, it will be advisable to design new buildings so that immediate or future installations can be properly taken care of.

Mistakes and costly changes can be avoided in the construction of plants, if the recommendations of the Underwriters are carefully considered beforehand by all parties interested.

It is the experience of the writer that the insurance companies welcome an opportunity to assist, in an advisory capacity, at all times.

Recommendations made by the Chicago Board of Fire Underwriters for the Construction of Packing Houses

The following recommendations are for mill constructed buildings. They conform to the general recommendations as made by the National Board of Fire Underwriters, although they differ from them in some respects, being more severe in several of their requirements.

Area

Maximum—10,000 square feet. Measurements to be made from the outer edge of enclosing walls and centre of dividing or party walls.

For each 2,500 square feet of area in excess of 10,000, there will be an additional charge of one cent for each story of building, excluding basement.

For area less than 10,000 square feet, deduct for each 2,500 square feet, one cent for each story in height. These additions and deductions to be made from the following basis rates for the heights of the buildings.

1 story and basement—basis	30c
2 story and basement—basis	35c
3 story and basement—basis	40c
4 story and basement—basis	45c
5 story and basement—basis	55c
6 story and basement—basis	65c
7 story and basement—basis	80c
8 story and basement—basis	100c

For each additional story over 8, add 25c.

Walls

All outside walls or party walls to be of the thickness given in the table following.

Party walls to extend four feet above the roof and be 16 inches in thickness and properly coped.

Parapet walls to be 16 inches in thickness and to extend four feet above the roof line. All parapet walls must be properly coped.

TABLE OF WALL THICKNESS IN INCHES

	Basement	1st	2d	3d	4th	5th	6th	7th	8th	9th	10th
1-story	16	16									
2-story	16	16	16								
3-story	16	16	16	16							
4-story	20	20	16	16	16						
5-story	24	20	20	16	16	16					
6-story	24	20	20	20	16	16	16				
7-story	24	20	20	20	20	16	16	16			
8-story	24	24	24	20	20	20	16	16	16		
9-story	28	24	24	24	20	20	20	16	16	16	
10-story	32	28	28	24	24	24	20	20	20	16	16

Communication

All communication between adjoining buildings to be through fireproof vestibules, with openings protected by double fire doors, built of standard construction with No. 10 plate iron. For door openings not through vestibules, there is a charge of ten cents for the first and two cents for each additional opening.

Vestibules

To be built with not less than 16-inch walls which must be carried at least three feet above the roof line and properly coped. Floors and roof to be made of fireproof construction. Stairs and elevators in vestibules to be of non-combustible material with iron or cement treads for stairs.

Floors

Thickness of mill floors to be not less than 3½ inches. Floor joists and girders to be not less than 72 square inches.

Bridge or Viaduct Connections

If of open construction and door openings protected by double fire doors, no charge. For covered and enclosed frame or ironclad viaducts with approved double fire doors or vestibule, five cents charge.

For covered and enclosed frames or ironclad viaducts without approved double fire doors, 10 cents charge.

Sectional Area

All supporting columns not less than 10x10 inches sectional area. No bearing timber to be supported by unprotected iron or steel.

For floors deficient in thickness (less than 3¾ inches), add one cent for each floor per inch of deficiency.

For supporting timbers deficient in size (less than 72 square inches), add two cents.

For timbers supported by unprotected iron or steel, add five cents for first floor and two cents for each additional floor. If supported by unprotected cast iron columns, add one-fourth of the above charge.

Ceilings

If ceiling joists are covered on the underside with wood boards or wood lath and plaster, add for each story, two cents.

For plaster on metal lath, leaving hollow space, add one cent.

Roof

Roof boards to be not less than two inches thick and all supporting timber not less than 72 inches in sectional

area. For deficient thickness of roof boards, add one cent, for deficient size of timber, add two cents, roof materials must be of non-combustible materials.

Skylights

Size not to exceed one-half the area of the roof. Skylight frames to be of metal or tile, if of wood, metal-clad. All glass to be wire glass. Wood skylights or skylights with ordinary glass add one cent for each 10 square feet of skylight, not exceeding a charge of 25 cents.

Elevators

To be placed in fireproof vestibules where the arrangement will permit. When otherwise located, to be inclosed with selfsupporting brick shafts and extend four feet above the roof. All openings to be provided with fire doors at each landing. Roof of elevator shaft to be covered with skylight or have ventilator at least one-twentieth of the area of the shaft, except when there are windows in shaft, which open into street, alley or court.

Elevators which are enclosed in 4-inch tile partitions supported from the floor construction at each story and with approved fire doors, add one cent charge for each story and one-half the charge for each additional elevator.

Stairway

To be placed in fireproof vestibules where arrangement will permit. When located in buildings, to be enclosed in brick shaft with self closing fire doors, skylight and ventilator in roof as prescribed for elevator shafts.

Partitions

To be avoided where possible. When built, should be of fireproof materials, tile, mackolite or plastered on steel studding and anchored to the floor and ceiling. For 1¾-inch dressed and matched plank partitions, add for each floor subdivided, two cents.

Exposures

All outside openings exposed within 100 feet, to be protected by approved iron shutters or approved wire glass

windows. For brick buildings where this is done, no exposure charge will be made.

Stand Pipes

All buildings of an area of 10,000 square feet, should be equipped with four-inch stand pipe, located inside of fire-proof vestibule and equipped with standard hose connections, hose and hose reel on each floor.

Packing and Slaughter House Schedule for the Middle West Outside of Chicago

The following recommendations for the construction of packing plants outside of Chicago, have been made by the insurance companies and where they are strictly followed, the plant will be rated as a standard plant; if the required fire protection is also provided.

Construction

Brick or stone, standard mill or semi-mill construction floors and roof, with bays at least three feet (to centres).

Area

Not to exceed 10,000 square feet on each floor.

Height

Not over three stories and basement, or 40 feet.

Walls

Standard thickness for one-story building to be 16 inches; two-story building 20 inches to 16 inches, and three-story building 24 inches to 20 inches to 16 inches. Division and all outside walls to be at least 16 inches at the top story, and division walls to extend at least four feet above roof, in parapet and coped.

Ventilators, Texas or Additions on Roof

To be entirely of metal or tile and not to exceed one-half the area of roof, windows and light openings to be protected by wire-glass or screens.

Stairways and Elevators

To be in brick tower or vestibule, with approved fire doors at floor openings or if the elevator is inside of the building, to have automatic hatches. Stairs inside to have self-closing doors.

Boilers

To be outside or if in adjoining building, to be thoroughly cut off by approved fire doors.

Boiler Stack

To be brick or metal stack on brick base, the base rising at least four feet above boiler-house roof.

Heating

Steam or hot-water. Steam pipes to be protected with metal caps or thimbles of asbestos paper and tin.

Fire Protection

To be located within city limits and protected by city water hydrants and city fire department, also to have fire pump of not less than 500 gallons capacity per minute (where maximum capacity exceeds 250 hogs and (or) 50 cattle per day), with suction in reservoir (or other supply) of at least 100,000 gallons of water, supplying standpipes of not less than two and one-half or three inches in diameter, running through warehouse or factory buildings, with standard couplings on each floor and on roof, to which hose can be attached.

Fire Hose

To be not less than two or two and one-half inches size, attached to standpipe on each floor and on roof, sufficient to reach all parts of the house.

Fire Buckets

To have fire buckets filled with salt water, or chemical fire extinguishers and fire ax on each floor.

Ladders

Permanent on each building.

Deficiency Charges

The following are the principal deficiency charges for brick buildings, which can be avoided by careful planning and construction.

Height

For each additional story over three or each additional 10 feet over 40 and not over 80 feet, add 0.05, if over 80 feet add, in addition to the above charges, 0.26.

Area

Not to exceed 10,000 square feet. For each additional 5,000 square feet over 10,000 add .10.

Walls

If outside walls or division walls are not standard, add to each building or division for each wall .05. If division walls are not built as parapet walls at least four feet above the roof and properly coped add .05. If brick walls are furred inside with wood, add .05. Roofs, shingle or board, add 0.26.

Skylights, or Additions to Roof

If constructed of wood and covered with iron and slate, add .16.

If exceeding one-half the area of the roof, add to the above item, .26.

Note—The above charges do not apply to condenser structures on the roof. For wooden ventilators on roof, add .06.

Stairs

If open or cased with wood and not located in brick vestibules or tower with fire doors, add .10.

If inside the building and inclosed with wood partitions and self-closing doors, add .05.

Elevators

If open or cased in wood and not located in brick vestibule or tower with fire doors, add .21. If inside and with automatic hatches, add .10.

Beef or hog-drops not cut off, add .05.

For continuous openings through or in the floors, for cold air ducts or ventilators, add .10.

Note—Separate openings from brine chambers to individual coolers may be permitted without charge when the pipe loft is immediately above the cooler.

Door Openings

(Not cumulative, except to covered and enclosed frame loading platforms, runways, shipping or car-icing sheds or docks, for which a specific charge should be made, in addition to other door opening charge).

For openings in division walls protected by approved single fire doors, add .27.

For openings in division walls protected by double fire doors not standard, add .21.

For openings in division walls protected by standard double fire doors, add .16.

Fire Protection

If outside of city water or city fire department protection, add .53.

If with city water but hydrants not within 300 feet or in less than 6 inch main, add .16.

If without standard reservoir for pump, add .27.

If without standard standpipe or fire hose equipment, add .11.

If without stand fire buckets, or chemical fire extinguishers and ax on each floor, add .11.

If inside or outside hydrants not kept open, or if without constant water pressure on inside standpipe, where used (other than inside chilling or curing rooms), add .06.

Basis Rates (Sole or Principal Occupancy)

Pork and Beef warehouses	$1.06
Boiler and Engine House	1.33
Tank House-Rendering	1.59
Tin Can Factory or Tin Shop	1.59
Fertilizer-manufacturing and Storage	2.12
Smoke House	1.59
Sausage Factory	1.59
Oleo and Butterine manufactory	1.85
Canning Factory	1.85
Lard Refining and Oil Pressing	1.85
Oil and Bone House and storage	1.85
Laundry with drying room, fireproof	1.59
Hair and wool drying room, fireproof	2.12
Glue Factory and storage	1.59
Soap Factory and storage	1.85
Machine Shop	1.06
Box Factory, no passing	1.59
Ice Manufacturing and storage, if in separate building	1.33
Brick shipping and car icing sheds	1.59
Platforms and runways	1.59
Frame platforms, runways, icing sheds and shipping platforms	2.12
Frame stock pens—in yards—drives, viaducts and yard buildings	2.12
Brick stables and barns	1.06
Dressing Rooms and lockers (separate buildings)	1.59

Buildings having two or more classes of occupancy, shall take basis rate according to the greatest hazard, with additions as per schedule to each building or division.

Bridge or Viaduct Connections

For covered and enclosed frame or ironclad connections, with approved double fire doors or vestibule, add .05.

For covered and enclosed frame or ironclad connections, without approved double fire doors or vestibule, add .10.

Coopering or Box Making

By hand or power, sawing or nailing, add .10.

Dressing Rooms and Lockers

If inside or in addition not cut off and not fireproof, add .16.

CHAPTER XXIII

ESTIMATES AND COST

Preliminary Estimates

In order to furnish an owner with an estimate of the cost of contemplated improvements, it is necessary to make preliminary drawings of the building. These are needed to determine the amount of material which is required in the construction.

A fairly accurate estimate can be made by figuring the amount of concrete, brick, lumber, and other items which enter into the construction, at the prevailing market prices.

The character of the building and the conditions under which the work must be performed, will have their influence on the cost, and to make even an approximate estimate requires both experience and careful consideration of the work in hand. Estimating is not an exact science like mathematics. Contractors who make it their business to know what buildings are worth, will frequently vary as much as 50% in the estimates on the same building. It should also be considered that the cost of labor and material changes from year to year and varies greatly in different localities.

Approximate Estimating Prices

The author is using the following figures for estimating cost of buildings in the Middle Western States:

Excavation	.50	per cubic yard.
Concrete Floor	6.00	per cubic yard.
Concrete Foundation-walls with forms	8.00	per cubic yard.
Reinforced Concrete-1-2-4 mixture	8.00	per cubic yard.
Cellar Floor—6-inch thick	.15	per square foot.
Reinforcing Steel	40.00	per ton
Placing Steel	5.00 to 10.00	per ton
Forming Floors	.10	per square foot.

APPROXIMATE ESTIMATING PRICES—CONTINUED.

Forming Columns	.50	per lineal foot.
Forming Beams & Girders	.40	per lineal foot.
Brick-work	15.00	per 1000 brick.
Pressed Brick	30.00	per 1000 brick.
Structural Steel—erected	55.00	per ton
Lumber	40.00	per 1000 B/M ft.
Flooring	70.00	per 1000 B/M ft.
Roofing	5.00	per 100 square ft.
Asphalt Paving	2.00	per square yard.
Brick Paving—on edge on cinder fill	1.35	per square yard.
Brick Paving—flat on cinder fill	1.00	per square yard.
Brick Paving—over concrete floor paving only	.80	per square yard.
Wood Paving—over 6-inch Cinder Concrete	1.65	per square yard.
Windows—complete per sq. feet	.50	per square foot.
Fireproof Windows per sq. feet	.80	per square foot.
Doors—per sq. feet	.50	per square foot.
Steel Fire Doors	1.00	per square foot.
Sash with Glass	.20	per square foot.
Corkboard Insulation—per B/M foot—erected	.07 ½	per foot.
Plastering—two coats Port. Cement	.35	per square yard.
Painting—one coat	.10	per square yard.
Painting—two coats	.18	per square yard.
Painting—three coats	.25	per square yard.
Plumbing—Water closets in place complete	70.00	
Plumbing—Lavatories in place complete	50.00	
Plumbing—Urinals in place—complete	55.00	
Steel Stairs—3 feet to 3 feet 6-inch wide	8.00	per lineal ft. rise.
Stair—Railing— 1½-inch pipe	.60	per lineal ft. rise.
Newel Posts—Plain Cast Iron or Steel	5.00	each.

Installation of Equipment

The equipment must be listed and estimated by taking each item separately. This requires an intimate knowledge of the value of packing house machinery and the labor cost of installing same. The cost of installation will depend largely upon whether this is done by contract or by the owner's employees.

The author has found that a considerable saving in the construction of new plants is made where the installation of tracking, piping, and packing house machinery is done with skilled workmen, working under the direction of a

competent packing house superintendent. Materials and necessary tools should then be purchased by the owner. This method of handling the work will greatly reduce the cost of any changes made in the arrangement, which is always expensive when the work is done under contract. The tools and machinery which are used in the erection can afterwards be installed in the machine shop.

Cost of Packing Plants

The cost of a complete packing plant of fireproof construction will vary between 16 and 20 cents per cubic foot of building. This can roughly be proportioned as follows: 60% for building, and 40% for equipment.

Mill constructed plants will cost from 13 to 16 cents per cubic feet, complete with all necessary equipment.

Packing Plant—Chicago. Built in 1900 of Mill Construction. Size 1,700,000 cu. ft. Cost 12¼c per cubic ft., complete with machinery.
Beef plant—Chicago. Built in 1913, of Mill Construction. Size 650,000 cubic ft. Cost 16⅓ cents per cubic ft., complete with machinery.
Packing Plant—Burlington, Iowa. Built in 1908, of Mill Construction.
Size, 850,000 cubic ft. Cost 13.6c per cubic ft. complete with machinery.
Packing Plant—Sioux Falls, S. D. Built in 1911, of Fireproof and Mill Construction. Size 3,000,000 cu. ft. Cost 16¼ cents per cubic ft., complete with machinery.
Tank House—Ottumwa, Iowa. Built in 1909, Fireproof Construction.
Size, 160,000 cubic feet, cost 17¼c per cubic ft. complete with equipment.

Cost of Cold Storage Buildings

The cost of fireproof cold storage buildings with machinery, insulation, piping, electric wiring, elevators, etc., all complete and ready for operation, can be estimated at from 15 to 20 cents per cubic foot. The actual cost will depend largely upon the location and the amount of freezer storage in the building. Low temperature rooms require heavier insulation and more refrigerating capacity and the estimated cost must be figured accordingly.

Cold storage buildings of mill construction require the same amount of insulation and equipment as fireproof buildings. The difference in cost will, therefore, only be in

the construction of the building which can be placed at from 10 to 15 per cent less than it will cost to build of reinforced concrete. Where the building is designed for heavy floor loads and with the columns far apart, the concrete construction will often be the cheaper.

Comparative Cost of Concrete and Mill Construction

This is a topic which is frequently discussed and about which there seems to be some difference of opinion. The location of the building and the interior arrangement will have a great deal to do with the cost, in one way or the other, and in order to obtain an accurate comparison it would be necessary to design the building in both types of construction and secure estimates from builders on the cost of each.

By "Mill Construction" is meant a type of construction in which the walls are of masonry and the size of every post is not less than 10x10 inches, beams and girders not less than 6x12 inches and all floors at least three and one-half inches thick and the roof two and five-eighths inches thick.

The following comparison of cost may be of general interest. The figures were obtained from the office of a Chicago architect from the completed plans of factory buildings to be erected in that city.

One building was 100x100 feet, five stories high, with basement, and was designed for a live load of 280 pounds per square foot on all floors. The walls were of brick. The panels in the mill design were 14x16 feet and the concrete design was of the most economical type of flat slab concrete skeleton construction.

The actual bid for the mill construction building was $65,100.00 and for the concrete building $72,200.00, making a difference of $7,100.00 more for the concrete, an increase of about 11% above the mill.

Another building was seven stories high with basement, 68x75 feet, and was designed for a live load of 150 pounds per square foot. The panels in both designs were 16x18 feet. The mill construction cost $65,400.00 and the con-

crete $75,300.00, making a difference of $9,900.00 more for the concrete, or an increase of about 15%.

These prices would be typical in Chicago or any other city where high-priced union labor is used and building materials are expensive.

In localities where lower priced labor can be had, there would be less difference in the cost between the two types of construction, principally because the concrete and the reinforcing steel could be handled by common labor.

Where lumber is available at very low prices the difference may be still further in favor of mill construction. Much depends upon the size of the floor panels and the load to be carried. In a building with 16x16 foot panels the cost of the two types of construction would be about the same, when the load equals 350 pounds per square foot. When the column spacing is over 16 feet, the increase in cost, due to the large size timbers required makes mill construction very expensive and steel or concrete can, therefore, be employed to better advantage.

CHAPTER XXIV

MISCELLANEOUS INFORMATION

Floor Loads

Floor loads in packing plants vary according to the occupancy of the building and each floor must be designed for the maximum load which it is supposed to carry.

Some allowance should be made for a possible change in the occupancy in small plants, where the future growth of the business often requires that changes be made in the old arrangement, which may necessitate the strengthening of a weak floor, due to a heavier load being placed on the floor than it was originally designed to support. It was at one time the policy of one of the largest packing firms in Chicago, to design all the floors in their manufacturing and storage buildings for a live load of 250 pounds per square foot. This enabled them to use any floor in these buildings for heavy storage purposes and undoubtedly saved a lot of money during the period of rapid growth and development of their various plants.

When the occupancy of a building is of a fixed character and the possibility of converting it into a different use is remote, there is no advantage in designing the floors heavier than is required. This will include such buildings as tank houses, smoke houses, killing floors and permanent office buildings.

In this connection it is well to remember that all structural material is used with a large margin of safety and when an owner demands that his building should be designed good and strong, he may not always take into consideration that a floor which is designed for 200 pounds will often carry four to six times as much before it will fail.

Where buildings are constructed under the supervision of City Building Departments, their requirements regarding the construction and loads must be followed. However, these requirements apply more to buildings which are subject to general classification than to packing houses.

In Chicago, the minimum load for all classes of mercantile and storage buildings is 100 pounds per square foot of floor surface. When heavier loads are to be carried the floors must be designed accordingly and the Building Department requires that placards be posted in each room stating the load for which each particular floor or panel is designed.

Packing house floors have, in the past, very frequently been constructed with small regard for the actual requirements which they had to take care of, and there are few of the old buildings in which the floors have remained as they were originally built. Only too often do we find that the construction has sagged and settled so that the slope to gutters and floor-drains is insufficient to properly drain the floors. These conditions are often caused by carelessness or lack of forethought on the part of the designer, who neglects to take care of special requirements.

There are, for example, in manufacturing buildings, many floor panels which carry the load of tanks or machinery. This load is of a more permanent nature than the load on the other panels and will in time cause the floor to sag, unless the construction and foundations have been designed to take care of such conditions. The same consideration should be given to any part of a floor which supports vibrating machinery, such as hog scrapers, fertilizer dryers or stick rolls.

In a well designed plant, the nature of the loading should be carefully considered and the size of the foundation made in accordance therewith. This is particularly important when the plant is located on alluvial soil, which is frequently the case with packing plants.

To accurately determine the load on storage floors, it is necessary to know the weight of the product and the

manner in which the goods are handled and stored. The amount of packing house products which may be piled on the floor is only limited by the height of the ceiling, and when the available storage space is scarce it is surprising how much the packer can pile on the floor, regardless of what it is supposed to carry.

The conditions and loads which may be found on any floor in all buildings are as follows:

1st—Weight of commodities in storage.

2nd—Average load from manufacturing process.

3rd—Weight of special equipment and machinery.

4th—Vibration caused by machinery or moving loads, such as live stock or meats on overhead rails and conveyors.

5th—Weight of floor construction.

The failures of packing house floors which have come to the author's attention, have generally been caused by excessive loading of floors in rooms with high ceilings. There is always the temptation to overload, under crowded conditions, and a careful designer will add to the strength of such floors as an added guarantee of safety.

Table of Minimum Live Load for Packing House Floor

The following table gives the minimum live loads per square foot of floor area for which it is safe to design the floors of the various packing house buildings, with story-heights of eleven feet or under. To these loads must be added the weight of the floor construction and any heavy machinery or equipment.

MINIMUM LIVE LOAD FOR PACKING HOUSE FLOORS.

Beef Cooler Floors	100 lbs. per sq. foot.
Beef Cooler Ceilings	300 lbs. per lineal foot rail (Beef in sides)
Beef Cooler Ceilings	175 lbs. per lineal foot rail (Beef in quarters)
Bone Cooking Rooms	150 lbs. per sq. foot.
Bone Storage	150 lbs. per sq. foot.
Canning Rooms	150 lbs. per sq. foot.
Casing Storage	200 lbs. per sq. foot.
Cattle Pens	100 lbs. per sq. foot.
Curing Coolers	150 lbs. per sq. foot. (S. P. Meat)
Curing Coolers 300 to	400 lbs. per sq. foot. (D. S. Meat)
Curing Coolers	275 lbs. per sq foot. (Beef in tierces)
Cutting Rooms	125 lbs. per sq. foot.
Cooper Shop	150 lbs. per sq. foot.
Dressing Room	100 lbs. per sq. foot.

MINIMUM LIVE LOAD FOR PACKING HOUSE FLOORS—CONTINUED.

Fat Chilling	200 lbs. per sq. foot.
Fertilizer Storage	300 lbs. per sq. foot.
Fertilizer Storage	200 lbs. per sq. foot. (Drying and cooling).
Freezer Storage.	
Beef piled loose on floor....	200 lbs. per sq. foot.
Sheep piled loose on floor....	175 lbs. per sq. foot.
Offal Freezer	300 lbs. per sq. foot.
Sharp freezer with racks	200 lbs. per sq. foot.
Storage freezer	300 lbs. per sq. foot.
Hair Drying and Storage.........	200 lbs. per sq. foot.
Hide Storage	250 lbs. per sq. foot.
Hide Pickling Vats...............	300 lbs. per sq. foot.
Hog Coolers—floor	100 lbs. per sq. foot.
Hog Coolers—ceiling	200 lbs. per lin. foot of rail.
Hog Pens	100 lbs. per sq. foot.
Killing Floors	125 lbs. per sq. foot.
Lard Refinery	150 lbs. per sq. foot.
Lard Storage Coolers	200 lbs. per sq. foot.
Offal Floors	125 lbs. per sq. foot.
Offices	100 lbs. per sq. foot.
Oleo Seeding and Clarifying......	150 lbs. per sq. foot.
Oleo Storage Cooler.............	200 lbs. per sq. foot.
Smoke House	100 lbs. per sq. foot.
Smoked Meat Packing...........	150 lbs. per sq. foot.
Sausage Factory	150 lbs. per sq. foot.
Summer Sausage Hanging Floor. Floor	100 lbs. per sq. foot.
Shipping Rooms	150 lbs. per sq. foot.
Sheep Cooler—floor	100 lbs. per sq. foot.
Sheep Cooler—ceiling	175 lbs. per lin. foot of rail.
Sheep Pens	100 lbs. per sq. foot.
Stearine Storage	200 lbs. per sq. foot.
Stables	100 lbs. per sq. foot.
Tank Houses	100 lbs. per sq. foot.
Tin Storage	150 lbs. per sq. foot.
Tallow and Grease Storage......	200 lbs. per sq. foot.
Wool Washing	175 lbs. per sq. foot.
Wool Drying	100 lbs. per sq. foot.
Wool Storage (baled)	150 lbs. per sq. foot.

Cold Storage and Freezing Temperatures for Various Products

The following list of products held in cold storage and the proper freezing temperatures for storing, is taken from Madison Cooper's book,* "Practical Cold Storage." Mr. Cooper states that the temperatures, as given, should be considered as a guide only and that they are subject to the changes required to meet varying conditions under which the goods are stored.

*Practical Cold Storage. Published by Nickerson & Collins Co., Chicago.

COLD STORAGE AND FREEZING TEMPERATURES FOR VARIOUS PRODUCTS.

Products.	Degree Fahr.
Apple Butter	42
Apples	30
Asparagus	33
Bananas	58
Beans (dried)	45
Beer (bottled)	45
Berries, fresh (few days only)	40
Buckwheat Flour	42
Bulbs	34
Butter	14
Butterine	20
Cabbage	31
Canned Fruits	40
Canned Meats	40
Cantaloupes (short carry)	40
Cantaloupes (one to two months)	33
Carrots	33
Caviar	36
Celery	32
Cheese	35
Chestnuts	34
Chocolate Dipping Room	65
Cider	32
Cigars	42
Corn (dried)	45
Corn Meal	42
Cranberries	33
Cream (short carry)	33
Cucumbers	38
Currants (few days only)	32
Cut Roses	36
Dates	55
Dried Beef	40
Dried Fish	40
Dried Fruits	40
Eggs	30
Ferns	28
Field Grown Roses	32
Figs	55
Fish (fresh water, after frozen)	18
Fish, not frozen (short carry)	28
Fish, salt-water (after frozen)	15
Fish (to freeze)	5
Frog Legs (after frozen)	18
Fruit Trees	30
Fur and Fabric Room	28
Furs (undressed)	35
Game (after frozen)	10
Game (short carry)	28
Game (to freeze)	0
Ginger Ale	36
Grapes	36
Hams (not brined)	20

COLD STORAGE AND FREEZING TEMPERATURES FOR VARIOUS PRODUCTS—CONTINUED.

Hogs	30
Hops	32
Huckleberries (frozen, long carry)	20
Ice Cream (few days only)	15
Ice Storage Room (refrigerated)	28
Japanese Fern Balls	31
Lard	40
Lemons (long carry)	38
Lemons (short carry)	50
Lily of the Valley Pips	25
Livers	20
Maple Sugar	45
Maple Syrup	45
Meat, fresh (10 to 30 days)	30
Meat, fresh (few days only)	35
Meat, salt (after curing)	43
Mild Cured Pickled Salmon	33
Milk (short carry)	35
Nursery Stock	30
Nuts in Shell	40
Oatmeal	42
Oils	45
Oleomargerine	20
Onions	32
Oranges (long carry)	34
Oranges (short carry)	50
Oxtails	30
Oysters (iced in tubs)	35
Oysters, in shell	43
Palm Seeds	38
Parsnips	32
Peach Butter	42
Peaches (short carry)	50
Pears	33
Peas (dried)	45
Plums (one to two months)	32
Potatoes	34
Poultry (after frozen)	10
Poultry, dressed (iced)	30
Poultry (short carry)	28
Poultry (to freeze)	0
Raisins	55
Ribs (not brined)	20
Salt Meat curing room	33
Sardines (canned)	40
Sauerkraut	38
Sausage Casings	20
Scallops (after frozen)	16
Shoulders (not brined)	20
Strained Honey	45
Sugar	45
Syrup	45
Tenderloin, etc.	33
Tobacco	42

COLD STORAGE AND FREEZING TEMPERATURES FOR VARIOUS PRODUCTS—CONTINUED.

Tomatoes (ripe)	42
Veal	30
Watermelon (short carry)	40
Wheat Flour	42
Wines	50

Cold Storage Rates

The following rates on commodities, held in storage, was prepared by the manager of a commercial cold storage plant in Chicago. They are fair averages of what is charged, where there is competitive cold storage facilities:

Commodity.	
Apples, in bbls. ....40c to	50c per season to May 1.
Apples, in boxes	15c per season to May 1.
Ale and Beer	25c per bbl. per month.
Butter, in tubs ....7c to	10c per tub per month.
Cheese, in boxes	1/10c per lb. per month.
Celery, in crates	20c per crate per month.
Cabbage, in crates	20c per crate per month.
Eggs, in cases ....(per month)	10c first month, 5c thereafter.
Eggs, in cases..(per season) 30c to	40c to Jan. 1st.
Fruits, Dried	⅛c per lb. per month.
Berries, in baskets	½c per basket per month.
Grape Fruit, in cases	10c per case per month.
Cranberries, in cases	10c per case per month.
Lemons, in cases	10c per case per month.
Oranges, in cases	10c per case per month.
Pears, in boxes	5c per box per month.
Game, brace	⅛c per lb. per month.
Lard, in tierces .... 35c to	50c per tierce per month.
Lard, in pails	1/10c per lb. per month.
Meats, fresh or frozen Beef ..1/6c to	1/10c per lb. per month.
Meats, fresh or frozen Mutton 1/6c to	1/10c per lb. per month.
Meats, fresh or frozen Pork..1/6c to	1/10c per lb. per month.
Meats, fresh or frozen Livers	⅛c per. lb per month.
Meats, Fresh or frozen Spare Ribs	⅛c per lb per month.
Meats, Canned	⅛c per lb. per month.
Meats, Sweet Pickled	1/10c per lb. per month.
Meats, Dry Salt (loose)	1/10c per lb. per month.
Meats, Cured, (in tierces)...35c to	50c per tierce per month.
Meats, Veal Carcasses with hide on	⅛c per lb. per month.
Nuts, in sacks	1/10c per lb. per month.
Onions, in boxes	15c per box per month.
Poultry, in boxes, fresh or frozen,	⅛c per lb. per month.
Sauerkraut, in bbls.	50c per bbl. per month.

CHAPTER XXV

GOVERNMENT REGULATIONS

The following regulations pertaining to construction and sanitation apply to all packing plants, which are operated under Government inspection. They are extracts from "Regulations governing the meat inspection of the United States Department of Agriculture," issued July 30, 1914, and are of special interest to designers of packing plants.

For the purposes of these regulations the following words, phrases, names, and terms shall be construed respectively to mean:

Regulation 1

Paragraph 18. Carcass—All parts, including viscera, of a slaughtered animal that are capable of being used as human food.

Paragraph 19. Primal Parts—The usual sections, cuts, or parts of the dressed carcass commonly known to the trade, such as sides, quarters, shoulders, hams, backs, bellies, beef tongues, and beef livers, before they have been cut, shredded, or otherwise subdivided preliminary to use in the manufacture of meat food products.

Paragraph 20. Meat Product—Any edible part of the carcass of any cattle, sheep, swine, or goat, which is not manufactured, cured, smoked, processed, or otherwise treated.

Paragraph 21. Meat Food Product—Any article of food or any article which enters into the composition of food for human consumption, which is derived or prepared, in whole or in part, from any portion of the carcass of any cattle, sheep, swine or goat, if such portion is all or a consider-

able and definite portion of the article, except such articles as organo-therapeutic substances, meat juice, meat extract, and the like, which are only for medicinal purposes and are advertised only to the medical profession.

Paragraph 22. Meat and Products—Carcasses, parts of carcasses, meat, products, food products, meat products, and meat food products of, or derived from, cattle, sheep, swine, and goats, which are capable of being used as food by man.

Regulation 7

SECTION 1—Office room, including light and heat, shall be provided by official establishments, rent free, for the exclusive use, for official purposes, of the inspector and other bureau employees assigned thereto. The room or rooms set apart for this purpose shall meet with the approval of the inspector in charge and shall be conveniently located, properly ventilated, and provided with lockers suitable for the protection and storage of bureau supplies and with facilities suitable for the dressing of bureau employees.

SECTION 5—When required by the chief of bureau or the inspector in charge, the following facilities and conditions, and such others as may be essential to efficient conduct of inspection, shall be provided by each official establishment:

(*a*) Satisfactory pens, equipment, and assistants for conducting ante-mortem inspection and for separating, marking, and holding apart from passed animals those marked "U. S. suspect" and those marked "U. S. condemned."

(*b*) Sufficient natural light, and abundant artificial light at times of the day when natural light may not be adequate, at places for inspection. Such places shall be kept sufficiently free of steam and vapors for inspection to be properly made.

(*c*) Racks, receptacles, or other suitable devices for retaining such parts as the head, tongue, tail, thymus gland, and viscera, and all parts and blood to be used in the preparation of meat food products or medical products, until

after the post-mortem examination is completed, in order that they may be identified in case of condemnation of the carcass; equipment, trucks, and receptacles for the handling of viscera of slaughtered animals so as to prevent contact with the floor; trucks, racks, marked receptacles, tables, or other necessary equipment for the separate and sanitary handling of carcasses or parts passed for sterilization.

(*d*) Tables, benches, and other equipment on which inspection is performed of such design, material and construction as to enable bureau employees to conduct their inspection in a ready, efficient, and cleanly manner.

(*e*) Sanitary water-tight metal trucks or receptacles for holding and handling diseased carcasses and parts; such trucks or receptacles to be marked in a conspicuous manner with the phrase "U. S. condemned," in letters not less than 2 inches high, and, when required by the inspector in charge, to be equipped with facilities for locking or sealing.

(*f*) Adequate arrangements, including disinfectants. for cleansing and disinfecting hands, for sterilizing all implements used in dressing diseased carcasses, and for disinfecting hides, floors, and such other articles and places as many be contaminated by diseased carcasses or otherwise.

(*g*) In establishments in which slaughtering is done, rooms, compartments, or specially prepared open places, to be known as "final inspection places," at which the final inspection of retained carcasses shall be conducted. Final inspection places shall be sufficient in size and their rail arrangement and other equipment shall be adequate to prevent carcasses and parts passed for food or sterilization from being contaminated by contact with condemned carcasses or parts. They shall be equipped with hot water, stationary washstands, and sanitary tables and other apparatus essential to a ready, efficient, and sanitary conduct of the inspection. The floors shall be of sanitary construction and shall have proper sewer connections, and when the final inspection place is part of a larger floor it shall be separated by a curb and railing.

(*h*) In each establishment at which any condemned article is held until a day subsequent to its condemnation, a suitably located room or compartment in which the same shall be placed. This room or compartment shall be secure, rat-proof, and susceptible of being kept clean, including a sanitary disposition of the floor liquids. It shall be equipped for secure locking, and shall be held under a lock furnished by the department, the key of which shall not leave the custody of a bureau employee. The door or doors of such room or compartment shall be conspicuously marked with the phrase "U. S. condemned" in letters not less than 2 inches high.

(*i*) Rooms, compartments and receptacles in such number and in such locations as the needs of the inspection in the establishment may require, in which carcasses and products may be held for further inspection. These shall be equipped for secure locking and shall be held under locks furnished by the department, the keys of which shall not leave the custody of bureau employees. Every such room, compartment or receptacle shall be conspicuously marked with the phrase "U. S. retained" in letters not less than 2 inches high.

(*j*) Adequate facilities, including denaturing materials, for the proper disposal of condemned articles in accordance with these regulations. Tanks which, under these regulations, must be sealed shall be properly equipped for sealing as may be specified by the chief of bureau.

(*k*) Docks and receiving rooms, to be designated by the establishment, with the approval of the inspector in charge, for the receipt and inspection of all meat and products as provided in section 4 of regulation 18.

(*l*) Suitable lockers in which brands bearing the inspection legend shall be kept when not in use. All such lockers shall be equipped for locking with locks to be supplied by the department, the keys of which shall not leave the custody of bureau employees.

Regulation 8

SECTION 1—Prior to the inauguration of inspection, an

examination of the establishment and premises shall be made by a bureau employee and the requirements for sanitation and the necessary facilities for inspection specified.

SECTION 2—Triplicate copies of plans, properly drawn to scale, and of specifications, including plumbing and drainage, for remodeling plants of official establishments and for new structures, shall be submitted to the chief of bureau in advance of construction.

SECTION 3. *Paragraph 1*—Official establishments, establishments at which market inspection is conducted, and premises on or in which any meat or product is prepared or handled by it for persons to whom certificates of exemption have been issued shall be maintained in sanitary condition, and to this end the requirements of paragraphs 2 to 8, inclusive, of this section shall be complied with.

Paragraph 2—There shall be abundant light, both natural and artificial, and sufficient ventilation for all rooms and compartments, to insure sanitary condition.

Paragraph 3—There shall be an efficient drainage and plumbing system for the establishment and premises, and all drains and gutters shall be properly installed with approved traps and vents.

Paragraph 4—The water supply shall be ample, clean and potable, with adequate facilities for its distribution in the plant. Every establishment shall make known, and whenever required shall afford opportunity for inspection of, the source of its water supply and the location and character of its reservoir and storage tanks.

Paragraph 5—The floors, walls, ceilings, partitions, posts, doors and other parts of all structures shall be of such materials, construction and finish as will make them susceptible of being readily and thoroughly cleaned. The floors shall be kept watertight. The rooms and compartments used for edible products shall be separate and distinct from those for inedible products.

Paragraph 6—The rooms and compartments in which any meat or product is prepared or handled shall be free

from odors from dressing and toilet rooms, catch basins, hide cellars, casing rooms, inedible tank and fertilizer rooms, and stables.

Paragraph 7—Every practicable precaution shall be taken to keep establishments free of flies, rats, mice and other vermin. The use of rat poisons is prohibited in rooms or compartments where any unpacked meat or product is stored or handled; but their use is not forbidden in hide cellars, inedible compartments, outbuildings, or similar places, or in storehouses containing canned or tierced products. So-called rat viruses shall not be used in any part of an establishment or the premises thereof.

Section 4—Adequate sanitary facilities and accommodations shall be furnished by every official establishment. Of these the following are specified:

(*a*) Dressing rooms, toilet rooms and urinals, sufficient in number, ample in size, conveniently located, properly ventilated, and meeting all requirements as to sanitary construction and equipment. These shall be separate from the rooms and compartments in which meat and products are prepared, stored or handled. Where both sexes are employed, separate facilities shall be provided.

(*b*) Modern lavatory accommodations, including running hot and cold water, soap, towels, etc. These shall be placed in or near the toilet and urinal rooms and also at such places as may be essential to assure cleanliness of all persons handling any meat or product.

(*c*) Properly located facilities for disinfecting and cleansing utensils and hands of all persons handling any meat or product.

(d) Cuspidors of such shape as not readily to be upset and of such material as to be readily disinfected. They shall be sufficient in number and accessibly placed in all rooms and places designated by the inspector in charge, and all persons who expectorate shall be required to use them.

Section 5—Equipment and utensils used for preparing, processing and otherwise handling any meat or product

shall be of such materials and construction as will make them susceptible of being readily and thoroughly cleaned and such as will insure strict cleanliness in the preparation and handling of all meats and products. Trucks and receptacles used for inedible products shall bear some conspicuous and distinctive mark and shall not be used for handling edible products.

SECTION 6—Rooms, compartments, places, equipment, and utensils used for preparing, storing, or otherwise handling any meat or products, and all other parts of the establishment, shall be kept clean and sanitary.

SECTION 7. *Paragraph 1*—Operations and procedures involving the preparation, storing or handling of any meat or product shall be strictly in accord with cleanly and sanitary methods.

Paragraph 2—Rooms and compartments in which inspections are made and those in which animals are slaughtered or any meat or product is processed or prepared shall be kept sufficiently free of steam and vapors to enable the bureau employees to make inspections and to insure cleanly operations. The walls and ceilings of rooms and compartments under refrigeration shall be kept reasonably free from moisture.

Paragraph 3—Butchers and others who dress or handle diseased carcasses or parts shall, before handling or dressing other carcasses or parts, cleanse their hands of grease, immerse them in a prescribed disinfectant, and rinse them in clean water. Implements used in dressing diseased carcasses shall be thoroughly cleansed in boiling water or in a prescribed disinfectant followed by rinsing in clean water. The employees of the establishment who handle any meat or product shall keep their hands clean, and in all cases after visiting the toilet rooms or urinals shall wash their hands before handling any meat or product or implements used in the preparation of the same.

Paragraph 4—Aprons and frocks and other outer clothing worn by persons who handle any meat or product shall

be of material that is readily cleansed and only clean garments shall be worn. Knife scabbards shall be kept clean.

Paragraph 5—Such practices as spitting on whetstones, placing skewers or knives in the mouth, inflating lungs or casings, or testing with air from the mouth such receptacles as tierces, kegs, casks and the like, containing or intended as containers of any meat or product, are prohibited. Only mechanical means may be used for testing.

Regulation 13

SECTION 1—All tanks and equipment used for rendering or preparing inedible products shall be in rooms or compartments separate from those used for rendering or preparing edible products. There shall be no connection, by means of pipes or otherwise, between tanks, rooms or compartments containing inedible products and those containing edible products.

SECTION 2—Every official establishment shall file with the department blue prints or other accurate diagrams showing all underground pipe lines and other equipment used to convey edible products and those used to convey inedible products, with a description giving the exact location, terminals and dimensions of such pipes and other equipment and of all gates, valves, or other controlling apparatus, and designating the lines used for conveying edible products and those used for conveying inedible products, and shall also file a copy thereof with the inspector in charge. Like prints or diagrams of alterations in existing tank rooms or tanks and of new tank houses or tanks of official establishments shall be furnished to the department and approved by the chief of bureau before the same are constructed. If no such underground pipe line or equipment is used for any of the purposes mentioned in this section, a written statement certifying to that fact and duly signed by the proprietor or operator of the establishment shall be filed with the department.

SECTION 3. *Paragraph 1*—In conveying to the inedible-product tank carcasses of animals which have been con-

demned on ante-mortem inspection, they shall not be taken through rooms or compartments in which any meat product is prepared, handled or stored.

Paragraph 2—Under no circumstances shall the carcass of any animal which has died otherwise than by slaughter be brought into any room or compartment in which any meat or product is prepared, handled or stored.

Paragraph 3—No dead animal shall, under any circumstances, be brought from outside the premises of an official establishment into any room or compartment thereof where any meat or product is prepared; nor, unless permission therefor in advance shall be obtained from the Secretary of Agriculture, shall any dead animal be brought into rooms or compartments where inedible products are prepared. "Dead animal," within the meaning of this paragraph, shall be construed to include any animal which died without having been inspected under these regulations.

Paragraph 4—Inedible fats from outside the premises of an official establishment shall not be received except into the tank room provided for inedible products, and then only when their receipt into the tank room produces no insanitary condition on the premises. When so received, they shall not enter any room or compartment used for edible products.

TOPICAL INDEX

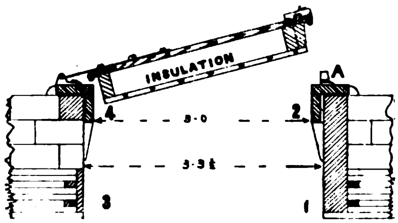
DOORS

DOORS are just a big valve, and are a weak point in all cold storage. Insulation is important, tightness and quickness are vastly more so. Leaks are an endless expense. Doors that bind and work badly are shut only when the workman can find no excuse for leaving them open, which is seldom, if ever.

The diagrams show a patented construction, contrived to avoid these troubles. The thick portion of the door fits loosely, so that considerable change of size, form and position, due to wear, swelling, etc., does not make it leak or bind.

The door is held to its seat against the front of the door frame, by powerful elastic hinges. Its self-acting Roller Fastener has enormous strength—is arranged for pad-lock—no slackening, as it latches—the soft hemp gasket in the joint is always in sight. A mere touch, frees and opens it from either side.

Old style doors when they work badly or leak, must be eased, thus forever destroying their fit. A slight readjustment of the door frame of these doors, restores them to perfect fit and freedom in a minute, at no expense.



As they do not stand in the doorway when open, its width can be six inches less than old style doorways—an important economy in refrigeration.

As constructed in this year, 1913, the opening in wall to receive these door frames should be 3½ inches wider and 4½ inches higher than the clear size of the doorway. Follow construction numbered 1 and 2.

For Overhead Track doors this rough opening should extend 13½ inches above the lower edge of the track bar. Door frames are secured with lag screws ⅜x4 inches inserted through front casing, inserted at A.

Fig. B shows wooden beveled threshold 1¾ inches thick. Connects lower ends of door frame, forms part of it and is let down into the floor. No feather edge, no jolt, no splinters. For warehouses, Accommodation Trucks.

Fig. C, concrete floors: shows lower ends of door frame extending down into the floor 3 inches, and connected by angle-irons extending across doorway from one side to the other, below the surface.

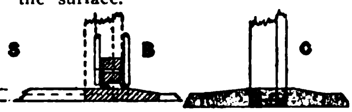


Fig. S shows door frame with full standard sill and head, used on all sizes of door frames. Suited only to walking through.

Special Freezer doors, on a modified plan for intermittent or continuous freezers, as well as for general purposes. Perfectly tight and perfectly free regardless of temperature, moisture or accumulation of ice in any degree.

Metal covered Fireproof Doors.

Revolving Ice Cream Doors—(Iron). Do not swell and bind.

Combined self-closing Ice Door and Chute of three styles. Ice Counters.

Form of specification: To guard against infringers and substitutes for our work, specifications should read, "Cold storage doors and door-frames with self-tightening hinges and fastener, complete, to be furnished by Stevenson Cold Storage Door Co., Chester, Pa."

Patents are granted or applied for on every valuable feature of this work. Infringers will be prosecuted.

STEVENSON COLD STORAGE DOOR CO.

Chester, Pa.

Packing House & Cold Storage
DOORS

For Freezers or Coolers, fireproof or non-fireproof. *Built* for strength, durability and insulating efficiency, with *double seals* of *contact*.

Insulated with 4", 5" or 6" of insulation of the kind you are using in your walls. No matter whether its Cork Board, Granulated Cork, Lith or other standard materials.

Hardware, our *Jones Automatic Self-tightening Fastner* and adjustable spring hinges, weighing 60 lbs. per set, indestructible.

☚ "Jones" Standard Cooler Door, with automatic trap lift for overhead Beef or Hog Rail.

96 page catalogue, profusely illustrated, upon request.

Used by most of the Big Packers everywhere.

JAMISON COLD STORAGE DOOR CO.

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The conditions under which you do business must be studied out before your refrigerating requirements can be met successfully.

We make a study of what your needs are before we attempt to supply them. The J-M Line is so complete that it embraces every approved insulating material for cold storage purposes.

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